THE

POPULAR SCIENCE MONTHLY.

AUGUST, 1886.

WOODS AND THEIR DESTRUCTIVE FUNGI.

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I.

IN the forests which have contributed so much to the industries and wealth of the United States there are seventy species of trees which have been and are of great commercial importance, and three hundred and forty more species which have an economic value. But few countries have so great a variety.

A section from the trunk of a tree of nearly the entire list of the species, gathered from all parts of the United States, can now be seen in the great and valuable collection in the American Museum of Natural History of New York City, contributed by Mr. Morris K. Jesup. The difficulties attending such a great work, so as to show the appearance of the wood and size of the tree with its bark, can only be fully appreciated by those actually engaged in making the collection. The magnitude of the work is without precedent; and, while it has been possible to transport across the continent a section of a tree, it has not been possible to fully protect some of them from the attacks of fungi, and some species will have to be replaced, while others by seasoning have checked the ravages of their fungi, but they show discoloration of the wood. To many this is an objection, but, by showing what species easily decay, it enhances the economic value of the collection. So many of our primitive forests have been cut, that many species for general use are already consumed, and the importance of these specimens for study, in making selections for substitutes, can not be overestimated.

An inspection of the different species shows the marked diversity in the structure and appearance of the woods, and one is quickly relieved of the general impression that they are all alike. Examined microscopically, the differences in structure are sufficient for identifi-

cation of the species, and at the same time enable one to judge of the suitability of a particular wood for definite uses. So little has been done in this country in the microscopical study of the woods for engineering, architectural, or mechanical purposes, that but few are aware of the variety in form and structure of the wood cells, ducts, and special fibers which make up the woody tissue of the different species. An expert can readily determine whether a certain wood, used for railroad-ties, will sustain the service of a trunk line, or is only suitable for a branch of limited traffic.

In the *Coniferæ*, which includes the pines, cedars, larches, redwoods, spruces, and firs, as a rule, each layer of growth only has two kinds of wood-cells called tracheids, one of thin walls and a large lumen, and the other of thick walls and a small lumen; when the former predominates, making nearly all of the layer, the wood is generally soft, as in the white pine (*Pinus strobus*, L.), the cedars, redwoods, spruces, and firs. When the thick-walled cells form one fourth to one half of the layer, the wood is much harder, as in the long-leaf yellow pine (*Pinus palustris*, Mill), *Pinus mitis*, and the larches. On the thin-

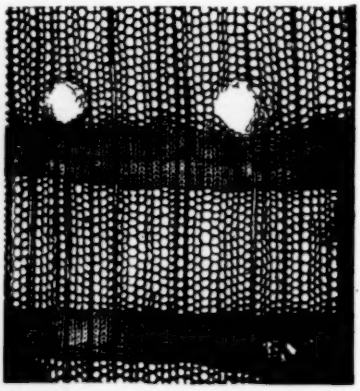

FIG. 1.—TRANSVERSE SECTION OF *Pinus palustris* (Mill), $\frac{2}{1}^{0}$.

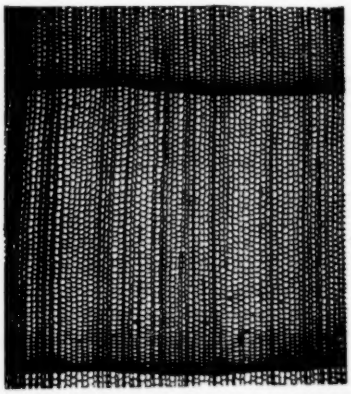

FIG 2.—TRANSVERSE SECTION OF *Chamæcyparis sphærorda* (Spach), $\frac{2}{1}^{0}$ (White Cedar).

walled cells of all the species of the *Coniferæ* are dome-like or lenticular markings, principally on the sides parallel to the medullary rays.

The thick-walled cells are often marked on the sides at right angles to the medullary rays. The *Coniferæ* have more or less resinous products, and the presence or absence of the upright resin-canals aid in distinguishing the genera, while the form and character of the medullary rays, the presence or absence of resin-ducts, the character of the cells, enable the species to be identified. In the alburnum or sap-wood, the starch is confined to the cells around the resin-canals and in the cells of the medullary rays.

The cellular structure of the oaks, chestnuts, hickories, ashes, walnuts, maples, beeches, birches, and magnolias is far more complex and

more highly differentiated than that of the conifers ; beside the wood-cells, there are ducts, vessels, and special cells containing starch in the alburnum or sap-wood. In nearly all the species of the first five orders mentioned, the ducts grow in concentric rows, in the first of the season's growth ; those which form later may be inclined through the layer of wood-cells, becoming smaller as they approach the outer portion. In the live oak, the ducts run radially through the ring, and the small fibers are nearly solid, giving the wood great hardness, making it so valuable for ship-building.

In the maples, beeches, birches, and magnolias the ducts are well interspersed through the entire ring, and are nearly of the same size. In the alburnum of these woods there are a great many cells which are filled with starch as reserve material, like the medullary rays in this portion of the wood. During active growth the starch is transformed and withdrawn. In the duramen but little starch remains, other products taking its place.

In the hard woods, all or portions of the annular rings are made up of hard and nearly solid fibers, while in the softer woods the walls are not so thick. In many of the species each layer of growth is not

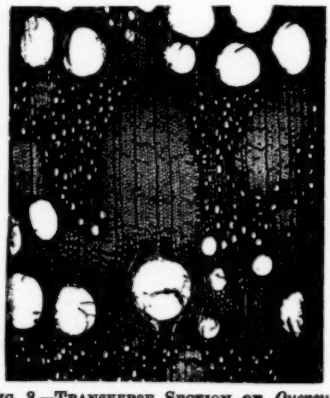

FIG. 3.—TRANSVERSE SECTION OF *Quercus alba*, $\frac{1}{2}^0$.

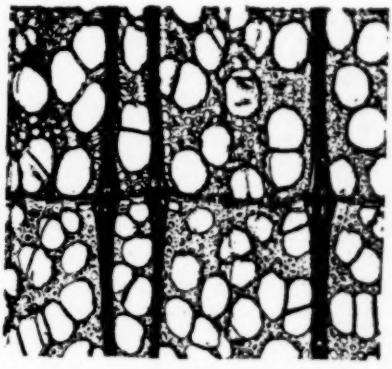

FIG. 4.—TRANSVERSE SECTION OF *Liriodendron tulipfera*, $\frac{1}{2}^0$ (White Wood).

of uniform thickness or quality, some having but comparatively few of the dense, hard fibers, the growth of these depending upon certain climatic conditions which may not yearly occur.

In the thick forests, under quite uniform conditions of growth, the thickness of the annular ring largely depends upon the leaf-area, which remaining practically the same in the older trees, the wood-cells forming upon a larger diameter, the rings as a rule are not so thick or dense as those grown when the tree is much younger.

Formerly, in lumbering, the trees were felled in the winter, cut into logs, sledded on the snow to the streams, and driven down in rafts in the spring to the mills. Now, with the log-railroads, they are independent of the snow, and in many camps lumbering is carried on

through the entire year. In the spring of 1876 I laid out a short log-railroad in the Michigan forests. The cut of the company for that year was 8,000,000 feet, board-measure; for 1886 it will be 120,000,000 feet, largely to supply the Atlantic coast with white-pine lumber.

Timber cut in the spring growth, when the starch in the sap-wood is transforming, furnishes in this part of the wood a good media for the growth of various ferments which produce decomposition in such products, and unless quickly checked will start the decay of the woody tissue.

It was the universal belief, until a few years since, and is still a common one, that the decay of timber was due to *Eremacausis*—slow combustion. It is to the improvement and use of the microscope and its accessories, that the true causes of decay of wood are found to be due to various forms of fungi. Many definite forms which cause fermentation have been traced and more are known to exist which are beyond the definition of present microscopes, unless they can be stained so as to differentiate them. Photo-micrographs, which give indications of structure far beyond what the eye can recognize, are important aids in this study, while the details they give of the structure of the wood could not be obtained in any other manner.

What are the fungi?

A great group of a low order of leafless and flowerless plants, destitute of chlorophyl, many of them microscopic, whose functions are under certain conditions to break up and liberate the compounds of and in the cell-structure, formed by chlorophyl-bearing leaves in the sunlight.

In short, the functions of the growing fungi are to undo and return to the air and soil the elements assimilated by the higher plants and trees in their woody structure during growth.

A mycologist would give a different definition of the fungi having reference to the form of fructification and spores, their functions being of less importance to him; while an epicure would only describe the mushrooms which please his taste.

It is now estimated that over fifty thousand species of fungi have been described; less than five hundred of them were known in the beginning of the century. A great number of the species are confined to special habitats, and all of them will not be found upon the woods. One fungus may only be found upon one or two species of wood, while others will be more general. The species we illustrate by cuts belong to the highest orders, and are typical to some extent of many others. Associated with these are some of unicellular structure, which belong to the genus *Saccharomycetes*—or budding fungi—of which the yeast-plant is typical; and others belong to the *Schizomycetes*, the fission fungi—bacteria, etc.—forms of which are attracting so much attention in connection with diseases of mankind.

Generally speaking, the first condition by which the higher fungi

—illustrated here—can be detected is by their mycelia, consisting of filaments of, usually, white cells, branching repeatedly by lateral ramifications, growing at their apices, lacing and interlacing, forming in many places dense, felted masses. When they grow on the under side of a plank, closely packed boards, and railroad-ties, they are often similar in form to that shown in Fig. 5. So far as the decay of the wood is concerned, the mycelia of the fungi is the most important part. Though these filaments are small, ranging from 0·0004 to 0·002 of an inch in diameter, they are able to pierce the walls of the wood-cells when softened by moisture, which many of them seem to generate to aid in their destructive work.

The fungi, instead of propagating by visible seeds, only have microscopic spores, which are freely disseminated by the air to resting-places. When proper conditions for germination occur, the spore sends out a mycelium, which, by spreading over the under side of a plank, as seen in Fig. 5, induces, sooner or later, the decomposition of the structure of its host, to partly build up its own.

Where it has once run over the wood in a dense growth, it destroys its strength from one eighth to three fourths of an inch in depth, and if the wood dries, cracks and crumbles to pieces (see Fig. 5)—it forms the so-called "dry rot" in timber, which is said to take place when the wood is perfectly dry. This is a misconception, as it is impossible for decay to commence without moisture, sufficient heat and access of air to supply the amount of oxygen needed in the reduction of the tissue to lower compounds.

If the wood does not dry, the mycelia continues to grow until all of the wood-cells are disorganized and fall to pieces, or, in other words, completely rotted. In many cases, the mycelia works in the inner portions of the timber, as explained later, and does not show exteriorly until decay is well advanced; this is especially true of larger timber.

"Dry rot" was named from the effect produced, and not the cause, to distinguish it from the so-called "wet rot." It has been an unfortunate designation, misleading many people, causing them to believe that timber will rot when dry, and proper precautions have not been taken to prevent decay, on the supposition that it would occur in any event.

The illustration in Fig. 5 is that of the mycelium of the *Polyporous radula* (? Fr.) spreading on the under side of the plank of station-platforms, which were destroyed in a year and a half to two years. It is typical of a large number of the mycelia of the fungi growing in similar conditions. One sees the same general appearance on lumber, plank, and sawed railroad-ties, which are piled together without being separated from each other by a small air-space. Hemlock inch boards can be completely rotted through in six to eight weeks of July and August weather, by the mycelia attacking both sides of the boards when damp, and piled up without an air-space between each. Cargoes

FIG. 5.—MYCELIUM OF THE FUNGUS, *Polyporus radula* (*) Fr.

of lumber and timber in long voyages are often badly injured by the growing mycelia between the pieces.

In bridges, ends of posts and struts, tenons and mortises, there are often similar growths of mycelia arising from the germination of spores by moisture, and decay eventually takes place. The illustration presented in Fig. 5 is one quite familiar to all who handle lumber and timber, but its import is not as generally understood as it should be, from the fact that such growths are thought to be due to the decay of the wood, instead of being the inducing cause.

A little more care in piling and stacking green lumber by producers and consumers, permitting circulation of air between each piece, would prevent the growth of various mycelia, and save annually large quantities of lumber.

If moisture collects and remains on seasoned timber, the mycelia will also grow and destroy it. Large timber should be seasoned under sheds, otherwise the sun will season an outside layer, preventing the escape of moisture, and internal growths of ferments and mycelia-fungi will destroy the inside of the timber, a thin outer shell remaining sound for some time.

The illustration is one of the most important that can be presented. It shows the destruction induced by the growing mycelium on the wood. On the right and lower edges, where the growth first appeared, it has caused the wood to crack not only with the fibers, but across, and in a short time longer it would have fallen to pieces, as portions of adjacent planks had some time previously.

The form of fructification of the fungus of mycelium shown in Fig. 5, as found, was *resupinate*, attached to the under side of the plank as that shown in Fig. 6, which is a species of *Polyporous* very destructive to hemlock in inclosed warm and damp places.

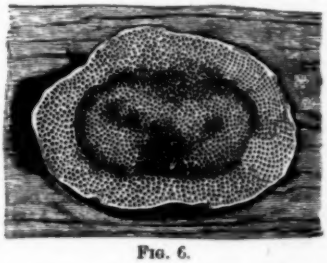

Fig. 6.

Resupinate forms of the *Polyporei* are very common on the under side of boards and timbers they are destroying, covering irregular areas; some will be ten by four inches, others follow along the edge of a board adjacent to a wall, ten to twenty inches, having an irregular width of one to two inches, the pores always pointing downward. A definite contour not being followed, identification of the species is often very difficult.

Fig. 7 shows the under and upper sides of the fruit of the fungus *Lentinus lepideus* (Fr.)—"Scaly Lentinus"—an agaric, and in this immediate territory is the one so destructive to timber of yellow or Georgia pine (*Pinus palustris*, Mill) in bridges, docks, and railroad-ties.

I have also found it upon the timber of *Pinus mitis*. Being the first

Fig. 5.—Mycelium of the Fungus, *Polyporus radula* (?) Fr.

to call attention to its destructive influence, its brief technical description will not be out of place: "Pileus fleshy, firm, convex, or expanded, nearly white, spotted with dark brown, appressed scales; lamellæ rather broad, not crowded, attached, slightly emarginate, and decurrent, white, the edge rough, eroded or torn, stipe firm, solid, equal or

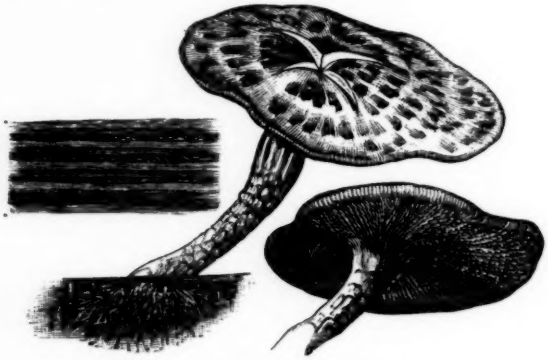

FIG. 7.—*Lentinus lepideus* (Fr.), one half size.

tapering downward, more or less scaly, whitish, sometimes eccentric, straight, or curved. Height, two to four inches; breadth of pileus, three to five inches; stipe, one half to three fourths of an inch thick."

Monstrous forms occur in dark situations with or without a pileus. Only a single stipe and pileus are here shown as emerging from a crevice in the wood; generally two, and sometimes four occur. The small block in Fig. 7 shows the mycelium in the longitudinal resin-ducts (see Fig. 1), which it readily pierces, hastening the destruction of the wood.

On the gills or lamellæ are borne the spores, which are 0·003 of an inch long, and 0·0013 of an inch in diameter, they are curved and one end apiculated; drop out and are carried by the wind to some resting-place; and when the proper conditions occur, germinate, sending out the mycelium, which only fruiting under very favorable conditions from June to September, the fruit is rarely found. I have seen many thousand ties in main tracks destroyed by it, without finding a specimen of the fruit; its mycelium is very abundant, and pierces the coarser cells of the wood with great rapidity, generating sufficient moisture, having an acid reaction, to carry on its destructive work, provided external heat and currents of air are not sufficient to dry the wood.

Examining many pieces of bridge-timber of *Pinus palustris* (Mill), which were horizontal, I found that where they had rested on others, sufficient moisture had collected to germinate the spores, and the mycelia had followed the longitudinal cells each way, meeting in the center, between the supports; the outer portions of the timber remaining dry, did not allow the moisture to escape, and the fungus was destroying the inside, while the outside looked sound. In bridge-plank the

moisture accumulated where it rested on the joists, the mycelia working upward and each way, usually leaving a thin portion of one eighth to one fourth of an inch in thickness, on the under side of the plank, where exposed to the air, giving the appearance that it was all sound. The abundant fructification during a brief warm rain in September, 1883, was the first indication of the destruction which had taken place.

The upright cells or tracheids composing the annular ring of the *Pinus palistris* (Mill) are of two kinds—one of thin and the other of thick walls ; the former fill the inner part of the ring, the latter the outer portion, giving the great strength and hardness characteristic of this wood ; interspersed through the ring are a few resin-ducts. In decay induced by its special fungus, the mycelium often separates some of the annual layers, and in most cases the thin-walled cells are first softened. Driving spikes into railroad-ties of this wood breaks and loosens the layers, and facilitates the entrance of the mycelium, and then larvæ, from one sixteenth to one eighth of an inch in length, eat and bore in the large softened tracheids, leaving the harder ones, so that in ties of four to seven years' service we often find little more than a series of nearly separated shells. The mycelium of this fungus once in a road-bed lives for some time, and in summer is ready to attack new ties of this timber as soon as put in the ground. I have noticed ties taken up, after a short service of six to eight months, which were covered on the bottom by the branching mycelium, and after drying one eighth to one fourth of an inch in depth would crumble to dust. It takes much longer for the mycelium to destroy the heart-wood of the yellow-pine sleepers from the bottom and sides than when it has access to the ends. In the first case it must nearly destroy the small medullary cells to reach the various rings, while from the end it has a larger area of the rings, which it readily follows. Painting the ends of this timber offers but little protection if the slightest opening occurs, as a spore can enter, grow, and carry on its destruction for a long time before it shows exterior decay.

The mycelium of *Lentinus lepideus* (Fr.) is composed of small branching filaments, only measuring 0·0004 of an inch to 0·0008 of an inch in diameter. With it I generally find an abundance of crystals of one form of oxalate of lime, and many cells of other fungi in adherent masses. The destructive power of this fungus is very great, and is causing enormous losses to consumers of the yellow pine, which are not realized or even suspected. In the sap-wood of this timber the fungus *Sphæria pilifera* (Fr.) readily grows, piercing the resin-ducts in the medullary rays, its hyphæ spreading to the upright resin-canals, and, from its abundance and dark color, discolors this portion of the wood ; which, if it remains damp and warm, the fermentation set up soon destroys the sap-wood. This fungus grows at a very low temperature, and is very destructive.

In new railroad-ties of yellow pine, which came from Georgia

February, 1886, for the use of New York roads, the sap-wood was already discolored, and some new growths of *Sphæria* took place here in March. Initial decay has already commenced in those ties, which will be facilitated by the conditions occurring when they are placed in the road-bed.

Fig. 8 is that of *Polyporous versicolor* (Fr.), which is very common and abundant, and is attached by its margin to the wood so that its form is called *dimidiate*. Several caps usually project one over the other, the lowest being the longest, each succeeding one above being shorter. On the under surface of each cap are the pores just visible to the eye, which bear the spores. The distinct colored bands or zones upon the upper surface give it a beautiful effect, as seen upon the wood it is destroying. It is easily found, as its substance is quite tough and dries before the insects and molds destroy it. It is generally abundant upon the sap-wood of white-oak piles, especially if the bark is left on after felling. It grows on the sap-wood of the white and red oak and chestnut ties; also upon the sap-wood of chestnut posts, and on the sap-wood and heart-wood of wild-cherry. As a rule, I found it more abundant on sap-wood of the oak than on chestnut ties. My observations refer to the entire length of the Boston and Albany Railroad, and many other roads in New England. The bark should be removed from piles and ties of the woods just mentioned, as it allows them to season and dry, checking the growth of this fungus; whether it is alone capable of destroying the heart-wood of chestnut ties has not been ascertained. I never found it growing there, but, instead, *Fistulina hepatica*—*Agaricus Americanus* (Pk.), *Polyporus pergamenus* (Fr.), *Dædalea quercina* (P.), and *Polyporus hirsutus* (Fr.), the latter being very abundant in old chestnut ties put in a temporary embankment at Worcester, Massachusetts. It was also abundant in the chestnut curbing of some of the unused hydrants.

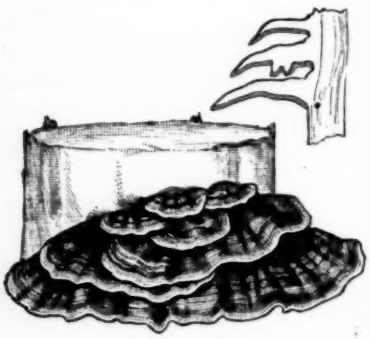

FIG. 8.—*Polyporous versicolor* (Fr.).

The heart-wood of chestnut ties is not so quickly attacked by fungi as some other woods, most of them being removed on account of the mechanical destruction of the fibers under the rails before decay takes place. I have several specimens of mycelia in the heart-wood of chestnut ties, but have only found a few developed efforts of fructification.

Polyporous applanatus (Fr.) is frequently found upon the sap-wood of many oaks, and is the one I generally find upon the heart-wood of

white-oak ties. It is usually *dimidiate*, as shown in Fig. 9, though, when growing upon the under side of timber above-ground, it is often resupinate ; the pores all point downward, the substance of the cap is hard, and, if undisturbed, the pores in the next year's growth form over that of the preceding years, but, enlarging the area, many of them are found twelve to eighteen inches across, and by cutting through them so as to show the section, six to eight years' growth is often seen. In this figure but one year's growth has taken place ; frequently two caps form instead of only one, as here shown.

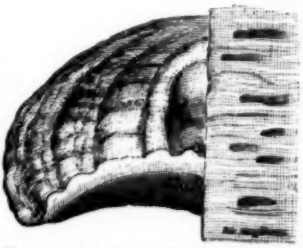

FIG. 9.—*Polyporous applanatus* (Fr.).

In white-oak timber and ties the earlier growth of the mycelium is not as continuous and uninterrupted as in the yellow pine, but grows more in little white patches, with considerable wood intervening between each. In Fig. 9 they are shown as dark spots. The massive bundles of medullary rays of this wood slowly decay, and preserve their form long after the other tissue has decayed. The large ducts seen in Fig. 3 are not open with a free communication, but filled with a delicate tissue, remains of which are visible in the cut ; this tissue will be found quite perfect in ties well advanced in decay.

The fungi so far illustrated in this paper apply mostly to the decay of timber under conditions similar to those of railroad service. In the next paper I shall give two or three illustrations of fungi of more general character. To deal with the great practical question of preventing wood from decay, the subject requires a more special treatment than it has received. Each species of tree, to a great extent, has special fungi, as it has insects which are not common upon other kinds of wood. Red cedar, cypress, locust, and catalpa are very durable in contact with the ground, where some others would quickly decay. The chemical composition of woods is not practically the same, as recently stated, but differs even in the sap- and heart-wood of the same species. Some of the woods have compounds in their cells easily induced to decompose and start the wood-tissue, while others have different compounds requiring inducing agents of greater intensities to begin decay ; and it is not true that a fungus which will destroy one wood will destroy all of the other species, and this one fact is of great practical importance, for, in a road-bed filled with the mycelium of one kind of decayed wood, another wood may be used which is not affected by that fungus, and its mycelium would be inert.

In treating wood it is found that the chemical which will prevent the germination of the spore of the fungus may not protect it from the attacks of its mycelium, contained in the ground or upon other decayed timber.

Experience has long since established the fact that wood kept per-

fectly dry will last for many hundreds of years, as has been the case in the roofs of foreign buildings, or when it is submerged in the water, as has been the case of piles used for foundations of the earlier bridges in older countries. Posts and telegraph-poles can daily be seen which are decaying near the ground-line, but sound above, after three to four years' service. By comparing the different conditions of use, it can be seen how little change is required to render unstable what would be stable under other circumstances. In roofs, the conditions are dryness, circulation of air, plenty of spores, and sufficient temperature to germinate, but the necessary moisture is absent. In the case of submerged piles, plenty of water, sufficient temperature, but exclusion of air, either to carry spores or permit them to grow. In the case of the posts and telegraph-poles we have the spores, the moisture, and the necessary temperature in summer for germination, and decay ensues from the fact that these are the essential conditions for the growth of the fungi whose work it is to undo and liberate the compounds in the woody tissue.

AN ECONOMIC STUDY OF MEXICO.

By Hon. DAVID A. WELLS.

V.

Present and Future Relations of the United States to Mexico.—The relations of the United States to Mexico naturally group themselves under two heads—political and commercial.

The political relations of the United States with Mexico, whether the people or the Government of the former wish it or not, are going to be intimate and complex in the future. The United States is geographically married to Mexico, and there can be no divorce between the parties. Intercommunication between the two countries, which a few years ago was very difficult, is now comparatively easy, and facilities for the same are rapidly increasing. And with the rapid increase of population in the United States, and with increased facilities for travel, the number of people—restless, adventurous, speculative, or otherwise minded—who are certain to cross the borders into Mexico for all purposes, good and bad, is likely to rapidly increase in the future. An extensive strip of territory within the Mexican frontier is already dominated, to a great extent, for the purposes of contraband trade, by a class of men who acknowledge no allegiance to any government, and whom the Mexican authorities tacitly admit they can not restrain. Out of such a condition of things political complications between the two countries, at no distant day, are almost certain to arise.

Again, in asserting the "Monroe doctrine," the United States virtually assumes a protectorate over Mexico. For, whatever else the Monroe doctrine may embody, it unmistakably says to Mexico: "You shall not change your form of government"; "You shall not enter into any European alliances"; "You shall not make cessions of territory, except as we (the United States) shall approve"; and in return "We will not allow any foreign power, ourselves excepted, to bully, invade, or subjugate you." It may be, and is, replied that the necessity of repelling from the outset any attempt at further aggrandizement of any European power on the North American Continent, with its contingent menace to the maintenance of democratic institutions, sufficiently justifies the assertion of the Monroe doctrine, and is for the good of Mexico as well as of the United States. But, at the same time, if there was any other power on the American Continent which should arrogate to itself the right to dictate to or control the United States, as the United States arrogates to itself the right to dictate to or control Mexico, and had sufficiency of power to make its assumptions respectable, could there be any doubt that the people of the Federal Union would regard such pretensions as a justifiable occasion for hostile protest and defiance?

Every right, however, carries with it and involves a duty; and the assertion of the Monroe doctrine by the United States carries with it an obligation of duty in respect to Mexico. What is that duty? Manifestly the duty which the strong owes to the weak. Not an offensive protectorate or meddlesome interference, but a kindly feeling and policy; manifesting itself in acts that will tend to promote the prosperity of our neighbor, and bring her willingly in accord with our own interests and wishes. Has that kindly feeling ever been manifested? To answer this question intelligently, one needs but to get a position outside of ourselves—more especially anywhere among the other people and states of the American Continent, north or south of our boundaries—when a little inquiry will satisfy, that the United States is regarded very much in the light of a great, overgrown, immensely powerful "bully," from whom no favor and scant justice are to be expected under any circumstances; and who would never hesitate, if interest or selfish indifference prompted, to remorselessly trample down—in the old Anglo-Saxon spirit (and as it always has)—any weaker or inferior race, Mexicans, Indians, or Chinese, the poor fishermen of Newfoundland, or again the negro, if political sentiment in respect to the latter was not running for the time being in another direction. And it is safe to say that to-day there is not a nation or people on the face of the globe, which is brought in intimate contact with us, but fears and hates us; and that, apart from a conservation of the principle of free government, which the United States is believed to typify, would not be glad if the power of the Federal Government were by some contingency to be impaired or destroyed. Is it not

time, therefore, that some steps should be taken to induce a different and a better state of feeling?

But, apart from any moral or ethical view of the situation, an exceptional, kindly treatment of Mexico ought to be a permanent national policy on the part of the United States, for reasons purely of self-interest, apart from any other motives. What Mexico most needs and what she has never had, unless the present Administration be an exception, is a stable, good government. Without such a government the large interests which citizens of the United States are acquiring in Mexico are sure to be imperiled. Some eighty million dollars of American capital are understood to be already represented in Mexican railway constructions; and other large investments have undoubtedly been made in mining and "ranching" in the country. Now, if history is to repeat itself, and there are to be further domestic revolutions and intestine strife in Mexico, and these American property interests or their owners are, as a consequence, to be arbitrarily or unjustly treated—i. e., in the way of confiscations, or forced contributions—resistance will follow; claims for damages will be created and pressed; national intervention will be sought for, and, in the present temper of the American people, will probably be granted—with a possible sequence of war and annexation. Certainly the last thing which the United States would be likely to tolerate, would be political chaos, with involved American interests, across its southern border. If it be said that there is no danger of this, it should be remembered that the present President of Mexico came to his office for the first time in 1876, through successful rebellion against the regularly elected authorities; during which period the Vera Cruz Railroad was destroyed at different points by the revolutionists, and all travel throughout the country greatly interrupted and made dangerous; and also that during the last twelve months there have been incipient rebellions against the central authorities.

But good government in Mexico is a matter not easy of attainment. There can be no good government in any country without good finance, and the finances of Mexico are always in an embarrassed condition; and this almost necessarily for a variety of reasons. In the first place, as already pointed out, the extreme poverty of the masses, the absence of accumulated wealth, the sluggishness of all societary movements, the practical exemption of land from taxation, and the adoption of a method of taxation that blights the harvest that it is desired to gather, all render the collection of an adequate annual revenue very difficult. Owing to the semi-civilized condition of its people, Mexico is necessarily obliged to support an army nearly double that of the United States (45,323 rank and file in 1883), to maintain anything like a permanent government; and the expenditure which this military establishment entails absorbs about one third part of the total revenue of the state, as compared with a present *direct* military ex-

penditure on the part of the United States, of not more than one tenth of its annual receipts.*

In a certain sense this large expenditure on the part of Mexico is for the direct benefit of the United States; for, if Mexico did not maintain reasonable peace and order throughout its great territory, the United States, having regard simply to its own peace and interests, would have to do it through military rule, on certainly so much of Mexico as is contiguous to the Federal dominions.

There can be no doubt, further, that there is a powerful party in Mexico—the old social leaders, and what considers itself the best society of the country—embracing the Church, the notables, and persons of wealth and ancient lineage allied with Spain—which is not at all in sympathy with the younger and progressive element of the nation, and sullenly opposes the introduction of railroads, and dislikes the United States. And this party would, if it could, dominate the policy of the country in all political and commercial questions. In proof and illustration of this, note the following extract from a recent article in the "Voz de Méjico" ("Voice of Mexico"), an able Catholic daily published in the city of Mexico, against the policy of admitting American capitalists into the republic:

"We combat," it says, "the policy of liberalism, which, greedy of material prosperity, and dazzled by the brilliancy of North American progress, opens freely the doors of our frontier to the capital of our neighbors. We do not oppose material progress, but we rather desire that it should come by natural steps, in proportion as the peace and public guarantees re-establish confidence and encourage the development of the country's own resources. Without foreign capital and without foreign labor, nothing or very little shall we be able to do, but we ought to refrain from calling in our neighbors, whose tendencies toward absorption are well known, in order that they shall decorate luxuriously our house and then install themselves in it definitely, relegating to us the departments of servitude. Prudent patriotism and good sense advise, therefore, that the cooperation of the Americans be dispensed with, although it be at the cost of material progress."

On the other hand, the present Government of Mexico seems to be cultivating and encouraging every effort, that may serve to strengthen society against the possibility of any conservative reaction.

Thus, the attitude of the Government toward the various Protestant sects, which are earnestly striving to gain a foothold in Mexico and extend their special theological views among its people, is well illustrated by the following answer which was returned some time since by the Governor of one of the important States of Mexico to a Protestant clergyman, who had made application for military protection for his church, against a threatened mob:

* The maximum military force of the United States allowed under existing laws is 2,155 commissioned officers and 25,000 enlisted men. The estimated cost of the military establishment of the United States for the current fiscal year, 1886–'87, exclusive of expenditures for public works, is $25,680,495.

"Sir, I willingly give you the desired protection, as it is my duty to see that the laws are respected; and, while I feel no interest whatever in your religious forms or opinions, we are all interested in encouraging the organization of a body of clergy strong enough to keep the old Church in check."

Whether the Catholic Church will accommodate itself to the new order of things, and be content to live peaceably side by side with civil liberty and full religious toleration, is yet to be determined. Ex-Consul Strother, who has already been often quoted as an authority, thus graphically exhibits the respective attitudes of the former and still great ecclesiastical power and its acknowledged antagonist, the Government: "They may be illustrated," he says, "by a glance at the Grand Plaza of the city, across an angle of which the palace of the liberal Government and the old cathedral stand looking askance at each other. On the one hand, at the guard-mounting, the serried lines of bayonets and the rolling drums appear as a daily reiterated menace and warning. On the other, we might naturally expect to hear from the cathedral towers a responsive peal of indignant protest and sullen defiance. Yet we remember that it is not the clergy, but the Government, which holds the bell-ropes."

Now, why should not the United States, which heretofore has been so prompt to sympathize with and even give material aid to the people of every Old World nationality struggling for freedom and against oppression—to Poland, Greece, Hungary, and Ireland—be equally ready to sympathize with and help the progressive party of Mexico, in the efforts they are unquestionably making to put their country in accord with the demands of a larger civilization?

But, assuming the general concurrence, on the part of the people of the United States, in the proposition that an exceptionally kindly treatment of Mexico ought to be a permanent policy of their Government, such a proposition, even if proclaimed in a joint resolution of both Houses of Congress, would be little other than an expression of sentiment, unless accompanied by practical action. But, through what measures, having this definite end in view, it may be asked, can practical action, not repugnant to the spirit of the Constitution or the precedents and traditions of the Government of the United States, be instituted? And, in answer, the following points are submitted for consideration:

First. That the Government and people of the United States should do all that can be reasonably asked of them to dispel the idea or suspicion, that now prevails throughout Mexico and all Central America, that the North Americans desire and intend, at no distant day, to take possession of all these countries, and destroy their present nationality. So long as this suspicion exists, the influence of the United States in Mexico and Central America, will be based to a great degree on apprehension, rather than liking. A return of the cannon and flags capt-

ured by the armies of the United States in the War of 1847, as heretofore proposed, would undoubtedly greatly contribute to dispel this feeling; but, apart from this, would it not be well for those who are especially anxious to send the gospel to the heathen, to consider whether it conduces to a higher life and civilization, for two neighboring nations to live on a basis, which, if made applicable to individual members of the same community, would be regarded as akin to barbarism?*

Second. The public debt of Mexico, which is recognized as valid, is estimated at about $90,000,000, and the obligations which it entails constitute a serious embarrassment to the Government, and a heavy burden upon the resources of the country. Numerous attempts have been made to fund it, with adequate provision for the payment of interest—the payment of the principal being regarded as hopeless; but all efforts thus far have practically amounted to nothing—a scheme by President Gonzales in 1884 for a new conversion, by the issue of bonds to the amount of $86,000,000, having well-nigh occasioned a revolution; not that Mexico wanted to repudiate, but because the whole measure was believed to be tainted with fraud. And yet it stands to reason that, so long as this debt remains unsettled, unsecured, and its interest regularly in default, Mexico, as a nation, can expect but little credit, no sound finance, and no sound government. And, imperative as is the problem, there seems but little present chance for Mexico to solve it. The United States could, however, easily accomplish it. With its interest guaranteed, the Mexican debt could undoubtedly be funded at from two to two and a half per cent interest, involving an annual charge, say, from $1,800,000 to $2,225,000—less than what is almost annually wasted on river and harbor improvements that subserve only private interests; and not much more than the four leading railroads of the Northwest have this year (1886) decided to add to their annual interest charges, for the purpose of extended constructions over territory that can at present return but little remunerative business. Is it a sum too great for the American people to pay, if it will help to give good government to a contiguous territory nearly as large as all of the United States east of the Mississippi?

That such a proposition is likely to be scouted, in the first instance, by the American public is to be anticipated. "Have we not debts enough of our own to pay," it may be asked, "without looking

* In 1878, Hon. John T. Morgan, United States Senator from Alabama, recognizing the importance of this matter, and after thus expressing himself in a speech—"Mexico is not destitute of a cause to look with jealous eye upon the people of the United States, while we on our part have the greatest reasons for treating her with a generous and magnanimous spirit"—proposed "that the United States should solemnly covenant, not to change the present limits of Mexico, nor to consent to their being changed by any other nation." The proposition, however, did not attract any attention, or lead to any official action.

after those of other people?" But let us reason a little. Can it be doubted that, after the termination of our late civil war, the United States would have practically enforced against the Maximilian government, had it been necessary, that phase of the Monroe doctrine, which affirms that European political jurisdiction shall not be enlarged on this continent? Fortunately, Mexico was able, out of its patriotism and sacrifice, to protect itself against the encroachment of foreign powers; and thus saved the United States from a conflict, that would have permanently increased the burden of its debt, by many times two million dollars.

Again, the demands of the world's commerce, for the establishment of speedy and cheap methods of transit across the narrow belt of Southern Mexico and Central America which separates the two oceans, are being recognized; and new routes supplying such conditions, at no distant day, are certain to be established. European sovereignty over them is, however, repugnant to the sentiment of the United States, and, if attempted, will probably be contested; and this, in turn, if anything more than words of protest are to be used, means formidable military and naval demonstrations and large expenditures. The people of the United States might, however, well hesitate before embarking in such an enterprise, in view of the fact that the foe which their forces would have to especially encounter and most dread, would be one against which neither courage nor skill would avail; for over all the low, tropical regions of Central America, where the routes for interoceanic transit have got to be constructed, the climate for unacclimated persons is most deadly—in proof of which the current mortality of Vera Cruz, San Blas, and the line of the Panama Canal may be cited; as well as the horrible historical experience of the forces, which the North American colonies sent in 1741 to co-operate with Admiral Vernon's expedition to Carthagena and the coasts of "Darien" (Panama). But Mexico is a nation of soldiers; and, if proper kindly relations were to be established between the two countries, the United States could confidently rely on, or employ the well-acclimated troops of the former, to guard any transit routes from foreign appropriation and control; even if a desire on the part of the people of Mexico and Central America to preserve the integrity of their own territories, was not sufficient to prompt them to defensive action. But kindly relations, between nations, are not to be established in a day and under the pressure of a one-sided necessity; and nations, as well as men, "gain doubly when they make foes friends."

Third. The commercial relations of the United States with Mexico are, to all intents and purposes, comprised in and identical with the system of railroads which American capital and enterprise have introduced into the latter country. Their introduction has constituted the last and the greatest revolution that Mexico has experienced since the achievement of her independence; for, with the means which they

have for the first time afforded the central Government for quick and ready communication between the remote portions of the republic, a stable government and a discontinuance of internal revolts and disturbances have for the first time become possible. Thus, to illustrate: Chihuahua, an important center of population, is distant a thousand miles or more from the city of Mexico; and between the two places, in addition, a somewhat formidable desert intervenes, of about a hundred miles in width, and over which the Mexican Central Railroad trains are obliged to carry a water-supply for their locomotives. Previous to 1883, if a revolution broke out in Chihuahua, the most ready method of communicating intelligence of the same to the central Government would have been to send a man on foot, probably an Indian runner. If the messenger averaged fifty miles a day, twenty days would have been consumed in reaching the city of Mexico, and from three to six weeks more at the very least, would have been required to dispatch a corps of trained soldiers from the capital, or some intermediate point, to the scene of the disturbance. But before this the revolutionists would have had all the opportunity for levying forced loans or direct plunder, or the gratification of private animosities, that their hearts could desire. And it is altogether probable that, in a majority of such cases, political grievances were merely alleged as a pretext for and a defense of plunder; and it is a wonder how, under such circumstances, there could be any desire for or expectation of accumulation through production, and that universal barbarism did not prevail. But now, under the railroad and its accompanying telegraph system, if anybody makes a *pronunciamiento* at Chihuahua, the Executive at the city of Mexico knows all the particulars immediately; within a few days a trained regiment or battalion is on the spot, and all concerned are so summarily treated, that it is safe to say that another similar lesson will not soon be required in that locality. The new railroad constructions were, therefore, absolutely essential to Mexico as a condition for a healthy national life, and the country could well afford to make great sacrifices to obtain and extend them, apart from any considerations affecting trade development.

But the American railroads in Mexico have, in addition, already done much to arouse the most stubbornly conservative people on the face of the globe from their lethargy, and in a manner that no other instrumentality probably could have effected. When the locomotive first appeared, it is said that the people of whole villages fled affrighted from their habitations, or organized processions with religious emblems and holy water, to exorcise and repel the monster. During the first year of the experience of the Mexican Central, armed guards also were considered an essential accompaniment of every train, as had been the case on the Vera Cruz Railroad since its opening in 1873. But all this is now a matter of the past; and so impressed is the Government with the importance of keeping its railroad system safe and intact, that the Mexi-

can Congress recently decreed instant execution, without any formal trial, to any one caught in the act of wrecking or robbing a train. That any improved methods of intercommunication between different people or countries—common roads, vessels, railroads, or vehicles, or the like—increase the production and exchange of commodities, is accepted as an economic axiom. But there could be no more striking and practical illustration of this law, than a little recent experience on the line of the Mexican National Railroad. The corn-crop, which is the main reliance of the people living along the present southern extension of this road for food, had for several years prior to 1885 failed by reason of drought; and, under ordinary circumstances, great suffering through starvation would inevitably have ensued. The natives, however, soon learned that with the railroad had come a ready market, at from two and a half to three cents per pound, for the fiber known as "*ixtle*"; the product of a species of agave, which grows in great abundance in the mountainous regions of their section of country, and which has recently come into extensive use in Europe and the United States for the manufacture of brushes, ladies' corsets, mats, cordage, etc. And so well have they improved their knowledge and opportunities, that the quantity of ixtle transported by the Mexican National Railroad has risen from 224,788 pounds in 1882 to 700,341 in 1883; to 3,498,407 in 1884; and 3,531,195 in the first seven months of 1885; while with the money proceeds, the producers have been able to buy more corn from Texas than they would have obtained had their crops been successful, and have had, in addition, and probably for the first time in their lives, some surplus cash to expend for other purposes. What sort of things these poor Mexican people would buy if they could, was indicated to the writer by seeing in the hut of a laborer, on the line of the Mexican Central Railroad—a place destitute of almost every comfort, or article of furniture or convenience—a bright, new, small kerosene-lamp, than which nothing that fell under his observation in Mexico, was more remarkable and interesting. Remarkable and interesting, because neither this man nor his father, possibly since the world to them began, had ever before known anything better than a blazing brand as a method for illumination at night; and had never had either the knowledge, the desire, or the means of obtaining anything superior. But at last, through contact with and employment on the American railroad, the desire, the opportunity, the means to purchase, and the knowledge of the simple mechanism of the lamp, had come to this humble, isolated Mexican peasant; and, out of the germ of progress thus spontaneously, as it were, developed by the wayside, may come influences more potent for civilization and the elevation of humanity in Mexico, than all that church and state have been able to effect within the last three centuries.

The projection and extension of the American system of railroads into Mexico commanded the almost universal approval of the people

of the United States. It was regarded as a measure in the interest of civilization, and as likely to be mutually and largely beneficial to the people of both nations. But for the United States and Mexico to maintain their present tariff restrictions on the international trade of the two countries, is to simply neutralize in a great degree the effect of the railways; and create conditions so antagonistic to the idea which a railway represents, that the investment of a large amount of money in their construction by citizens of the United States under existing circumstances, would seem almost akin to dementia. For it must be obvious that these restrictions produce exactly the same result as if, after the railways had been completed, an earthquake had thrown up a ridge directly across the lines, so steep and precipitous on the northern side as to add from thirty to forty per cent to the cost of all merchandise passing from the United States into Mexico, and so much more difficult of ascent on the southern side as to add some ninety per cent to the cost of all goods passing from Mexico into the United States. And, if such a physical calamity had actually occurred, the stockholders might reasonably doubt whether the lines were worth operating. But, at the same time, if there are any who expect that trade would immediately and largely increase between the two countries if all tariff restrictions were mutually abolished, they are certain to be disappointed. A large proportion of the people of Mexico—possibly nine tenths—will, for the present, buy nothing imported, whether there is a high tariff or no tariff—not because they do not want to, but because they are so poor that they can not buy under any circumstances; while the limited wealthy class will buy what they want of foreign products, irrespective of high duties. Again, the internal trade or distribution of merchandise in Mexico is, furthermore, largely in the hands of the Germans and English, who learn the language and conform to the customs and prejudices of the country much more readily than the Americans. They naturally prefer the products of their own countries; and German manufactures have been especially popular, "because they are as cheap as they are poor"; and the advantage of paying more for what will last longer is something very difficult to impress upon the ordinary Mexican. Another matter which practically works against the extension of trade with the United States is, that American houses will not sell their goods on the long credits demanded by Mexican purchasers. A gentleman conversant, through long residence in Mexico, thus writes in respect to this matter: "It is a serious mistake to look upon Mexican credit as something to be let alone. I can say with confidence, after diligent investigation, that mercantile credit in Mexico will average up as satisfactory as in the United States. Among the large mercantile houses in the interior of Mexico, as well as the importers, and the large sugar, grain, cotton, and cattle raisers, the moral sense in a square business dealing is as keen and as just and responsible as among the general run of customers in the United

States.* They are slow, but pay their bills, make few business compromises, and still fewer failures. From actual inspection of books of large houses in Mexico, exhibiting accounts of a series of years, I found that eighty-five to ninety per cent of long credit sales were paid in full. Not one American business man in five hundred will succeed in Mexico, for the sole reason that he attempts to force his own ways and methods upon a people whose habits and ways are the antipodes of his own. Our manners are not in accord with the extreme politeness and consideration to be found in Mexico. Business is largely done on the basis of feeling and sentiment, and established acquaintance. Neither has time nor money the transcendent value that it has with us." It is also interesting to note here, that for these, or some other reasons, there are comparatively few Jews in Mexico, and that as a race they do not seem to fancy the country, either as a place of residence or for the transaction of business.

But, notwithstanding all these obstacles to the extension of trade, the advantages from commercial intercourse with Mexico are all on the side of the United States. Commerce, in establishing a course between any two points, always follows the lines of least resistance. And to-day, through the establishment of railway lines, which furnish ample, rapid, and comparatively cheap facilities for transportation between the interior of Mexico and such great commercial and manufacturing centers as Chicago, Cincinnati, St. Louis, and Kansas City, the easiest movement for the commerce of Mexico is by and through the United States. One demonstration of this is to be found in the fact that the Mexican Central Railroad now carries considerable freight that comes to New York by European steamers, and is thence transported, in bond, by rail directly through to Mexico; to which it may be added that some $300,000 of this freight, during the past year, is understood to have been English agricultural machinery, which has been bought in preference to the world-wide famous American farm machinery and implements, and carried past, as it were, the very doors of the American competing factories! For such a singular result there are two explanations. One is, that not only in Mexico, but in all the Central and

* Consul-General Sutton, of Matamoras, tells the following story illustrative of the good faith in a mercantile transaction of the *rancheros* of Northern Mexico, the particulars of which were detailed to him by the parties concerned: "A German house in interior Mexico contracted for the purchase of two hundred mule-colts, to be delivered a year following; and payment, at the rate of twenty dollars a pair, was made in advance. A year elapsed, and the mules were not delivered. The head of the house would not, however, allow any message of inquiry or reminder to be sent, but remained quiet. A year after the stipulated time, the *rancheros* came in with the mules. There had been a disease and a drought, which had killed the colts the first year, and this was the reason assigned for not coming according to agreement. They sent no word, because it was so far, and they did not remember the name." When the firm counted the mules, they found that *three* had been brought for each pair stipulated and paid for; which was the way the *rancheros* quietly settled for their unavoidable breach of contract.

South American countries, the English and the German merchants take special pains, not only to adapt their merchandise to the peculiar tastes of the people with whom they wish to deal, but also to cultivate their good-will. The representatives of the United States, as a general rule, do neither. Another explanation is that our European competitors in foreign trade recognize at the outset, and at all times, that trade, especially when involving radical innovations on old-time precedents and usages, is not of spontaneous growth, but has got to be cultivated; that it is a system in which product is to be given for product, and service for service, and therefore, from its very nature, can not be a "one-sided business." Accordingly, the German and English merchants in Mexico take in exchange for such wares as they desire to sell, and at a certain price, whatever the Mexicans have to offer of their products. The American merchant, on the other hand, finding that the commercial policy of his country is based on the assumption that such a system of exchanges is not desirable, and that its existing laws make reciprocal trade difficult, does not seem even to attempt it. And in connection with this subject it may be stated, that during recent years German merchants have bought merchandise in New York, which American manufacturers have acquired particular advantages in producing, shipped the same to Hamburg, and after re-exporting to Mexico, sold them at cheaper rates than any American engaged in direct trade could afford to offer! How such a result, which on its face seems so mysterious and paradoxical, is accomplished, may be best explained by example. Thus, the German, who has become thoroughly conversant with Mexican methods of doing business, could sell say $3,000 worth of American cottons, furniture, sewing-machines, and the like, at cost, or possibly even less than cost, because his system of selling is to exchange them for $3,000 worth of Mexican products, which he can afterward sell, it may be, at $5,000, or a sum which would give him a fair return for all his risks and for long credits, and also reimburse him for all the expenses of extended transportation. And the Mexicans are contented with their share of the transaction, because nothing better is offered to them.

The annual value of the total import trade of Mexico is probably not in excess of $35,000,000; of which the United States already controls a large proportion. Thus, for the year 1883, the returned value of all merchandise exported from the United States to Mexico was $16,587,630; of which $14,370,992 was "domestic," and $2,216,638 "foreign" merchandise. This was, however, a year of very active railroad construction, with an abnormal employment of Mexican labor, and large disbursements of American capital in the country. Since then, there has been a marked falling off in exports from the United States (less than $13,000,000 in 1884), which has been attributed partly to the withholding of orders in anticipation of the ratification of a commercial treaty between the two countries, and partly to the

great depression of business consequent on the large decline in the price of silver.*

That the ratification of the contemplated treaty for commercial reciprocity between the United States and Mexico would have increased to some extent, and perhaps considerably, the volume of American exports, can not be doubted. Thus, for example, there are no articles of which Mexico stands in greater need than wagons and carts, barbed fence-wire, and petroleum and its derivatives for warming and lighting. In respect to the two first named, the existing Mexican tariff is almost prohibitory, and, as a consequence, it is asserted that there is not a respectable vehicle in any of the frontier towns of Mexico; and no means, in the absence of wood, of supplying a pressing and increasing need for fencing on the great *haciendas;* while the cost of all petroleum products is so much enhanced, as to greatly restrict their consumption for illumination and almost entirely preclude their use for warming, and this in a country destitute in great part of any cheap natural supply of either wood or coal. The removal of all duties on the import of merely these few articles into Mexico, as was provided in the proposed treaty, and their consequent very great cheapening, would therefore have been a boon to the people of Mexico, which they would not have failed to take advantage of to the utmost extent of their ability; and, for meeting any demand thus created, the manufacturers of the United States would have nothing to fear from any foreign competitors.

On the other hand, the arguments that have thus far proved most potent in preventing the ratification of such a treaty, on the part of the United States, have been based on the assumption that the free importation of Mexican raw sugars and unmanufactured tobacco, would prove injurious to the American sugar and tobacco interests. But the entire fallacy, or rather utter absurdity, of such assumptions would seem to be demonstrated: *First*, in respect to sugar, by the fact that, with unrefined sugar selling in Mexico for a much higher price (from twelve to twenty-four cents retail) than the same article in the United States, there have not yet been sufficient inducements held out to Mexican capital and labor, in the way of profit, to tempt

* How greatly the depreciation of silver affects the business interests of a country like Mexico, which not only uses a silver currency almost exclusively, but also relies on silver as one of its chief exports (i. e., for the payment of imports), is shown by the circumstance that the Directors of the Vera Cruz and City of Mexico Railroad reported at their annual meeting in London, on the 25th of May, 1886, that the loss of the company in exchange for the half-year ending December 31, 1885, was £29,641; on the gross earnings for the same period, of £302,134. They further add: "The average rate of exchange fell during the half-year from 41–46*d.* per dollar, at which it stood at the end of June 1885, to 40–45*d.* and since the beginning of the current half-year (1886) the rate has further fallen, and at the present time is 38–76*d.* On equal remittances made a year previously, when the average rate was 42–39, the loss would have been only £21,669, and thus an additional burden of £7,972 has been imposed on the shareholders."

them to fully supply to the domestic demand of the country for sugar from its undoubtedly great natural resources—*five and a half* dollars' worth of sugar having been exported from the United States into Mexico in 1883, for every one dollar's worth imported during the same year from Mexico into the United States; and, *secondly*, in respect to tobacco, by the testimony, based on careful investigation, of some of the best manufacturing authorities in the United States, that, while the best grades of tobacco for cigar purposes can now be raised in the United States at from ten to fifteen cents per pound, the cost of Mexican tobacco of a corresponding quality ranges from twenty-five to fifty cents per pound. It is difficult to see, therefore, what valid objections from merely trade considerations can be offered to the consummation of such a measure on the part of the United States, or to affirm which of the two countries would be the greatest gainer from the adoption of such a policy. Nay, more, it would be difficult for any one to show, wherein anything of commercial or industrial disadvantage could accrue to the United States, even if it were to allow every domestic product of Mexico to be imported into her territory free of all import taxes or restrictions—articles subject to internal revenue taxes in the United States being manifestly excepted—without asking any like concessions from Mexico in return. Such a proposition may at first seem preposterous, but let us reason a little about it. In the first place, it is exactly the policy which Great Britain now offers to Mexico. Can the United States afford to bid less for the trade of the American Continent than her great commercial rival? Again, Mexico wants, or is likely to want, everything which the United States especially desires to sell, and the only drawback to a great extension of trade between the two countries is the lack of ability on the part of Mexico to pay for what she wants. And this inability at the present time is very great. Apart from the precious metals, the quantity and value of domestic merchandise which Mexico can export to pay for such foreign products as she may desire, as already pointed out, are comparatively small, and consist almost exclusively of the most crude natural products. For the year 1883 nearly eleven twelfths of all her exports consisted of the ixtle and heniquen fibers; woods, mainly dye and ornamental; coffee, hides and skins, vanilla, horse-hair, catechu, and sarsaparilla. Notwithstanding, also, that Mexico is an agricultural country, she does not produce sufficient material (cotton and wool) to keep her small number of textile factories in operation; but imports about three fifths of her raw cotton from the United States (5,877,000 pounds in 1885), and a considerable portion of her wool from Australia. What Mexico would sell to the United States, if all tariff restrictions were removed from her exports, would be such crude materials as have been specified—all articles of prime necessity to the American manufacturer. Reduced to terms of labor, the exchanges would sub-

stantially be the product of twelve hours' hand-labor in Mexico for one hour's labor with machinery in the United States. A Committee of Ways and Means of the United States House of Representatives of the Forty-ninth Congress have reported adversely to the ratification of a commercial treaty with Mexico, mainly for three reasons: *First*, because Mexico is so poor; *second*, because "the American citizen living in Mexico, and pursuing the peaceful avocations of industry and commerce, is without adequate protection to life and property"; *third*, because "to speak of permanent and desirable commercial relations with a government and people so estranged from us in sentiment is without promise of substantial and successful results." The first of the reasons is economic, the second political, while the third, having due regard to its meaning, may be well termed "Mongolian"; and all are unsound. The poor countries are the very ones with which it is especially desirable that the United States should cultivate trade, for, if the volume of trade be small, the profit of such trade is large—as is always the case where the results of rude or hand labor are exchanged for machinery product. If the facts constituting the basis for the second reason are as alleged, commercial isolation and restriction are no remedy for them. Commercial intimacy between nations is always productive of political good-fellowship, as isolation and restriction are of enmity; and for promoting amity with Mexico the modern drummer is likely to prove, for the present, a far better missionary than either the diplomatist or the soldier; and, as for the third, one might think that a precedent had been borrowed by the committee from China, where commercial intercourse with the United States itself, in common with Europe, was, until very recently, combated on the ground that the inhabitants of these countries were "foreign devils," with whom the enlightened Chinese ought not to be brought in contact.

Such, then, in conclusion, are the views of the writer respecting the present and future relations of the United States to Mexico. If he has offered anything, in the way of fact or argument, which may induce a belief, by people of the former, that the subject is worthy of a larger and more kindly consideration on their part than it has hitherto received, he will feel that his "Economic Study" has not been wholly unsatisfactory.

THE EXTENSION OF SCIENTIFIC TEACHING.*

By Professor T. H. HUXLEY.

ONCE more reverting to reminiscence, the present state of scientific education surely presents a marvelous and a most satisfactory contrast to the time, well within my memory, when no systematic prac-

* From the President's Address before the Royal Society, delivered at the Anniversary Meeting, November 30, 1885.

tical instruction in any branch of experimental or observational science, except anatomy, was to be had in this country; and when there was no such thing as a physical, chemical, biological, or geological laboratory open to the students of any university, or to the pupils of any school, in the three kingdoms. Nor was there any university which recognized science as a faculty, nor a school, public or private, in which scientific instruction was represented by much more than the occasional visit of a vagrant orrery.

At the present moment, any one who desires to obtain a thoroughly scientific training has a choice among a dozen institutions; and elementary scientific instruction is, so to speak, brought to the doors of the poorer classes. If the rich are debarred from like advantages, it is their own affair; but even the most careful public-school education does not now wholly exclude the knowledge that there is such a thing as science from the mind of a young English gentleman. If science is not allowed a fair share of the children's bread, it is at any rate permitted to pick up the crumbs which fall from the time-table, and that is a great deal more than I once hoped to see in my lifetime.

I have followed precedent in leading you to the point at which it might be fair, as it certainly would be customary, to end by congratulating you, as Fellows of the Royal Society, on the past progress and the future prospects of the work which, for two centuries, it has been the aim of the society to forward. But it will perhaps be more profitable to consider that which remains to be done for the advancement of science than to "rest and be thankful" in the contemplation of that which has been done.

In all human affairs the irony of Fate plays a part, and, in the midst of our greatest satisfactions, "surgit amari aliquid." I should have been disposed to account for the particular drop of bitterness to which I am about to refer, by the sexagenarian state of mind, were it not that I find the same complaint in the mouths of the young and vigorous. Of late years it has struck me, with constantly increasing force, that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realization of their wishes. We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. If he were to attempt to do so, his mental faculties would be crushed by the multitudes of journals and of voluminous monographs which a too fertile press casts upon him. This was not the case in my young days. A diligent reader might then keep fairly informed of all that was going on, without robbing himself of leisure for original work, and without demoralizing his faculties by the accumulation of unassimilated information. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended

to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist, as time goes on.

I am happy to say that I do not think any such catastrophe a necessary consequence of the growth of science; but I do think it is a tendency to be feared, and an evil to be most carefully provided against. The man who works away at one corner of Nature, shutting his eyes to all the rest, diminishes his chances of seeing what is to be seen in that corner; for, as I need hardly remind my present hearers, that which the investigator perceives depends much more on that which lies behind his sense-organs than on the object in front of them.

It appears to me that the only defense against this tendency to the degeneration of scientific workers lies in the organization and extension of scientific education in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness.

I think it is quite possible to meet these requirements. There is no reason, in the nature of things, why the student who is destined for a scientific career should not, in the first place, go through a course of instruction such as would insure him a real, that is to say, a practical acquaintance with the elements of each of the great divisions of mathematical and physical science; nor why this instruction in what (if I may borrow a phrase from medicine) I may call the institutes of science should not be followed up by more special instruction, covering the whole field of that particular division in which the student eventually proposes to become a specialist. I say not only that there is no reason why this should not be done, but, on the ground of practical experience, I venture to add that there is no difficulty in doing it. Some thirty years ago my colleagues and I framed a scheme of instruction on the lines just indicated, for the students of the institution, which has grown into what is now known as the Normal School of Science and Royal School of Mines. We have found no obstacles in the way of carrying the scheme into practice except such as arise, partly, from the limitations of time forced upon us from without; and, partly, from the extremely defective character of ordinary education. With respect to the first difficulty, we ought, in my judgment, to bestow at least four, or better five, years on the work which has, at present, to be got through in three. And, as regards the second difficulty, we are hampered not only by the ignorance of even the rudiments of physical science, on the part of the students who come to us from ordinary schools, and by their very poor mathematical acquirements, but by the miserable character of the so-called literary training which they have undergone.

Nothing would help the man of science of the future to rise to the level of his great enterprise more effectually than certain modifications,

on the one hand, of primary and secondary school education, and, on the other, of the conditions which are attached by the universities to the attainment of their degrees and their rewards. As I ventured to remark some years ago, we want a most-favored-nation clause inserted in our treaty with educators. We have a right to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognized qualification for degrees, and in university honors and rewards. It must be recognized that science, as intellectual discipline, is at least as valuable, and, as knowledge, is at least as important, as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer.

Let me repeat that I say this, not as a depreciator of literature, but in the interests of literature. The reason why our young people are so often scandalously and lamentably deficient in literary knowledge, and still more in the feeling and the desire for literary excellence, lies in the fact that they have been withheld from a true literary training by the pretense of it, which too often passes under the name of classical instruction. Nothing is of more importance to the man of science than that he should appreciate the value of style, and the literary work of the school would be of infinite value to him if it taught him this one thing. But I do not believe that this is to be done by what is called forming one's self on classical models, or that the advice to give one's days and nights to the study of any great writer is of much value. "Le style est l'homme même," as a man of science who was a master of style has profoundly said; and aping somebody else does not help one to express one's self. A good style is the vivid expression of clear thinking, and it can be attained only by those who will take infinite pains, in the first place, to purge their own minds of ignorance and half-knowledge, and, in the second, to clothe their thoughts in the words which will most fitly convey them to the minds of others. I can conceive no greater help to our scientific students than that they should bring to their work the habit of mind which is implied in the power to write their own language in a good style. But this is exactly what our present so-called literary education so often fails to confer, even on those who have enjoyed its fullest advantages, while the ordinary schoolboy has rarely been even made aware that its attainment is a thing to be desired.

A CANADIAN CHAPTER IN AGRARIAN AGITATION.

By GEORGE ILES.

WHEN agrarian agitation is mentioned, one expects to hear of Ireland, the Isle of Skye, Scotland, or England. That American communities have been, and are, little troubled by disputes between landlord and tenant, is taken for matter of course, and not without reason. When fertile wild land could be had for nothing till within recent years, the struggle between proprietors and would-be proprietors could seldom become very severe. Questions as to the ultimate ownership of land are still practically in abeyance in the New World. Yet America has furnished interesting instances of agrarian agitation. Prodigal grants of land at nominal prices to colonizing corporations and railway companies have induced bitter and increasing complaints in the United States and Canada. Mr. Henry George's attacks on landed proprietorship originated from observation of the grasping policy of Californian owners of counties who waited idly for their property to acquire value from the neighborhood of industrious settlers. In a new country such holdings are very grievous to working settlers. Large uncultivated blocks separate farmers from their markets, add much to local taxation for roads and bridges, and materially enhance the difficulties of maintaining district schools. Hence, in the New Northwest, both American and Canadian, the advantages obtained from railways, aided by large land grants, are not procured without some sacrifices. These sacrifices are, however, rendered temporary by the alacrity of railway companies in settling their lands with a view to developing traffic. Colonization companies, so called, are everywhere less eager to part with their tracts, and the difficulties arising from this fact sometimes occasion distinct agrarian agitation. In Ontario, the chief province of the Canadian Dominion, one of the grievances of a generation ago was the possession of extensive areas by the Canada Company, which obtained its holdings at a nominal price on conditions notoriously disregarded.

It is, however, the agrarian agitation which took place, for more than a century, in Prince Edward Island, the smallest province of Canada, that is to be here sketched. The course of the struggle there between landlord and tenant may have interest in showing how the grantees of lands bestowed for colonization may shirk their engagements. And it may also show how the voting privileges of a democratic community modified an opposition to landlords which in Cork or Kerry might have gone to murderous lengths.

Prince Edward Island is one of the most beautiful agricultural districts of America. Its forests, fields, and meadows, vested in the crown, were in 1767 disposed of according to a method much in vogue

during the early days of British colonization. With the exception of three small reservations, intended for county towns, the island was divided into sixty-seven lots or townships of 20,000 acres. In one day sixty-five of these lots were disposed of by lottery before the Board of Trade and Plantations in London! The grants issued to the various allottees contained these among other conditions:

1. That the grantee of each township should place on the same, within ten years from the date of the grant, one person for every 200 acres, the settlers to be foreign Protestants, or persons who had resided in British America for two years previous to 1767.

2. That such portions of the land, where one third of the acreage was not so settled within four years of the date of the grants, should be forfeited.

3. That payment of quit-rent, varying from two to six shillings sterling per 100 acres, should be made by the allottees at the expiration of five years, payable annually on one half the grant; and, five years after that, payable on the whole.

On these terms the original proprietors took possession, and in the following year petitioned the British Government that the island might be given a separate government. To defray its expenses they proposed that a moiety of quit-rents due in five years should become payable in two—during May, 1769—payment of the remaining half to be postponed for twenty years. Trusting to the good faith and responsibility of the proprietors, a local government was accordingly established. This trust was disappointed. The quit-rents were not paid as agreed, and ten years after the grants had been conveyed the conditions of settlement had been complied with in but ten townships of the sixty-five. Nine others were settled in part, and all the remainder neglected. In no case were the settlers the foreign Protestants bargained for.

As time passed, the proprietors continued their disrespect for the conditions of tenure. The Legislature of the island constantly directed the attention of the Government at Westminster to the facts, and urged the escheat of the grants; holding, perhaps not very warrantably, that after escheat the tenants would enjoy their lands on better terms. Indulgence, however, was from time to time sought and received by the proprietors. Nevertheless, in 1802, the Colonial Secretary, in a dispatch to the governor of the island, ordered that such lands as were held by proprietors who had failed to perform their conditions of grant be escheated. Accordingly, the Legislature passed an act, the result of which would have been to revest in the crown nearly every acre in the colony. What became of this law is a mystery; it was sent from Charlottetown, the colonial capital, to London, for the royal allowance, and was never afterward heard of. In this same year (1802), the arrears of quit-rents had accumulated to £60,000; and the British Government, wishing to encourage the set-

tlement of the colony, determined to accept a moderate commutation. Leniency or favor was invariably shown proprietors who had complied in any degree with the conditions of their tenure. Yet this liberal measure was unavailing—the commuted arrears were not paid. Up to 1833 but £6,000 had been received for quit-rents, whereas the total due under the grants was £145,000. Meanwhile agitation on the subject among the islanders constantly increased, until the British Government was again urged to quiet its perturbed little colony.

Lord Goderich, Colonial Minister in 1832, made a thorough examination of the complaints of the islanders, embodying the result in a lengthy dispatch. He found large tracts unimproved, in expectation that their value would ultimately be raised by the exertions of those colonists who were busy cultivating their property. Vast areas of wild land separated farms from one another, the injustice being heightened by absenteeism of the landlords. Lord Goderich proposed that the quitrents due by the proprietors be exacted, and, as a concession, should be redeemable at fifteen years' purchase. His proposal was not acted upon, and the agitation on the island rose to an extreme. All this, too, with peculiar political conditions. The local Government, in the immediate presence of its governed population, was extremely sensitive to popular discontent. Agriculture was the main and almost the sole industry; the tenants were not mingled with any manufacturing or mercantile class, and the preponderant pressure of their interests was very manifest in a legislative hall which stood within an easy drive of the average island farm. The arm of law was enfeebled. Rents were usually allowed to fall into long arrears before resort was taken to legal measures of collection. It was common for a tenant to owe five to ten years' rent. Arrears, accumulated through sixteen and even eighteen years, were sometimes brought before the courts. Usually, in suits for rent, the landlord paid the costs himself, and did not exact interest. Frequently proprietary rights were disposed of to speculators for nominal sums. Every indulgence by landlord to tenant was interpreted by the latter as a just concession from the possessor of a faulty title. The cost of collecting such rents as were paid was commonly about one fourth.

For twenty-one years after Lord Goderich's vain recommendations, the agrarian history of Prince Edward Island was one of ceaseless turmoil. In 1853 an act was passed by the Provincial Legislature for the purchase of the estates of proprietors who might be disposed to sell. Between 1854 and 1871 thirteen estates, aggregating 457,260 acres, were bought at the moderate average price of $1.31 per acre. Of this area, 403,050 acres have been sold to 5,704 tenants, who have paid, for their average holdings of 70 acres, prices ranging from 94 cents to $3.40, and averaging $1.76. This act of 1853, which depended on the voluntary sale by proprietors of their lands, was too slow in operation for the discontented islanders. They obtained the concur-

rence of the Legislature and the landlords to a proposal that a commission be appointed with power to devise a system whereby leasehold lands might be converted into freehold. Accordingly, in 1860 a commission was constituted—Hon. John H. Gray being nominated by the British Government, Hon. Joseph Howe by the Legislature of the island, and Hon. J. W. Ritchie by the proprietors. The Legislature, most anxious for the quieting of an agitation which had done the colony incalculable harm, passed an act in advance to give effect to the award of the commissioners. That award, however, had no sooner been published, than the proprietors objected to the manner in which it provided for the valuation of land. This objection was sustained, the award set aside, and another attempt to quiet the strife between landlords and tenants proved fruitless. Wild excitement prevailed as a result of what was regarded as the bad faith of the proprietors. An organization known as the "Tenant League" came into existence, and resistance was offered to the collection of rent by civil officers. Frequent and violent riots gave the appearance of Erin itself to the colony, and troops from Halifax were summoned to quell the disturbances.

In 1862 the Provincial Government passed an act which expired in 1874, intended to give peace to the island. Under it tenants could offer to buy leased lands from landlords at fifteen years' purchase, the Government aiding by an advance to the extent of eight shillings and sixpence per acre at six per cent interest, all arrears of rent to May, 1853, due by purchasers, being canceled. This act also proved disappointing. Few tenants availed themselves of it, the majority of leaseholders entertaining the idea that the lands would come to them on better terms of purchase than those provided in the act, very probably after reversion to the crown.

Recognizing the failure of every attempt at grappling with the land question, by means which left solution to voluntary sales or voluntary purchases, the Island Legislature in 1868 urged on the British Government the necessity for the adoption of compulsory measures. The plea led to no action, pending the proposed entrance of Prince Edward Island as a member of the Canadian Confederation. That Confederation, established in 1867, made repeated overtures for the admission of the province before the union in 1873 was perfected. The terms of union provided the means of solving the question which for more than a century had troubled a fertile and promising province. It was agreed on entering the Confederation that the Island Government, which had no public lands and was surrendering its right to customs levies, should receive from the Dominion treasury $800,000; this enabled the province to purchase the township lands from proprietors on terms intended to be just and equitable. Three commissioners were appointed for the duty of purchase; the Governor-General appointed one, the Provincial Government the second, and each several

proprietor had the privilege of appointing the third for the hearing of his case. In estimating the compensation to be paid proprietors, the commissioners were required to consider :

1. The price at which other proprietors had already sold their lands to the Government.

2. The number of acres under lease in the estates valued, the length of such leases, the rents agreed for under these leases, the arrears of rent, the years over which they extended, and the reasonable probability of recovery.

3. The number of acres of vacant or unleased land ; their quality and value to the proprietor.

4. The gross rent actually paid for the previous six years ; the expenses of collecting such rent being deducted, to show the net amount actually received by the proprietor.

With Right Hon. Hugh E. Childers as chairman, the commission went to work, and the voluminous evidence presented to it reveals how thoroughly the tenants regarded their leases as unsound and illegal. Whenever a lease was taken as a basis of valuation, the plea was set up that the proprietor's title was faulty, and that he had leased property to which his right was doubtful. In vain was it contended that the whimsical conditions of the original grant had been impossible of fulfillment. The retort was repeated that, therefore, proprietorship should be forfeited, and it was held that landlord influences at Westminster had, in the early days of agitation, successfully fought off proposed concessions to tenants, which, if granted, would have spared the island grievous evils. The landlords maintained in their defense that their ownership had been repeatedly recognized by the Government, more particularly in the Fifteen Years' Purchase Act of 1865. They pleaded that, if they had not rigorously enforced claims against their tenants, their forbearance arose from no uncertainty as to their titles, but from humanity in cases where their tenants were needy, and from social and political prejudices against legal collection where their debtors were thriving. Leases, it was clear, were very far from being leases in the British, Irish, or American sense ; they were not contracts meaning what they said, but doubtful bargains open to discussion or rebate, just as the landlords' title could be discredited, indulgence obtained, or prosecution parried. Many tenants of rich land, abundantly able to pay their rent, had paid none. Often a tenant who had decried his leasehold as poor and unproductive, was proved to have disposed of it for a handsome sum. Parallel with the accumulating of arrears on landlords' ledgers had gone on the steady piling up by tenants as a class of savings in the banks. A disregard for property in rents extended itself to other kinds of property belonging to landed proprietors. It was not uncommon for woodlands to lose their value through being stripped of timber by thieves. When in an extreme case a tenant was ejected from his holding, no successor to him was to

be found. Once a sheriff bearing a writ was met by an armed mob, headed by a member of the Legislature.

A very significant element in the pleas made against the landlords, was that the labors of the tenants alone had imparted increasing values to the land in making fertile farms where there had been but wilderness. It was urged again and again that the toilers who had imparted value to property were entitled to proprietary rights, as against the holders of titles whose exertions had been confined to the collection of rent. Therefore, it was maintained, the Government should not, in buying lands, do so on the basis of capitalizing a rent which had, as a value, been chiefly created by the industry of tenants. A good many occupiers of land on short or uncertain leases plainly manifested the universal tendency of such tenure—bad farming and a feeble interest in improvement of any kind. Some of them were accustomed to reducing their indebtedness by sums ranging from five dollars down to five shillings. In every case the landlord's claim received such attention as it was convenient for the tenant to give it after the accounts of merchant, blacksmith, wagon-builder, or other creditor had been paid. This, too, when, even for good land, rent was rarely more than about ninepence sterling an acre. Incidentally, it was shown that the long coast-line of the island had had its effect in inducing many farmers to embark in fishing, and allegiance divided between land and sea gave agriculture but primitive development. Another fact of interest elicited was that the island had a most admirable fertilizer in the beds of mussel mud and shells bordering its shores, which, applied to the land, increased its yield from two to even ten fold for several years.

When the Land Commissioners had concluded their labors in court the experiment of tenant proprietorship began. It proved an experiment attended with many difficulties. The surveys of the lands had been very incomplete and imperfect, so that disputes as to boundaries were constant. The Government now finds that it has paid for 41,000 more acres than it has received. From doubtfulness in surveys and boundaries it was not uncommon for three or four persons each to claim the right to buy the freehold of the same property. The purchase of the land by Government having banished all fears of arrears of rent being exacted from former tenants, a general resurrection by former owners of old leases, agreements, and minutes developed an army of claimants for the right to buy. In addition to these elements of contention, the Government had to deal with hundreds of squatters, who by virtue of twenty years' occupation had acquired proprietary rights. During the years which have elapsed since the act went into force, its difficulties have been gradually overcome, chiefly through the judgment and ability of the commissioners who have administered it. Let some statistics of their labors be presented:

Up to December 31, 1885, the Government of Prince Edward Isl-

and had bought from proprietors 843,981 acres of land, and had sold 679,832 acres at an average price of $1.59 per acre. The usual Government terms of sale were one fifth cash, and the remainder payable in ten equal annual installments, with interest at six per cent. On December 31, 1882, the last date up to which statements regarding arrears were published, it was shown that by purchasers who had made no payments whatever during terms varying from three to fifteen years, $200,648 was due in arrears to the Government. A pretty general feeling seemed to prevail among them that new concessions would be granted delinquents, who as a class were numerous enough to make the authorities charged with collection very lenient indeed—to put it mildly.

In quieting disturbances and placing real estate in the hands of its occupiers and users, the Land Transfer Act did unquestionable good. In the passage and administration of the act a favoring of the tenants and ex-tenants is most manifest. Before sales to tenants began there was a classification of lands according to value, and tenants usually bought at prices somewhat below cost, and occasionally at prices much below cost. Tenants in buying properties which they had cultivated were freed from all arrears of rent due to the date of acquisition by Government. Improvements of all kinds which they had effected on their lands had been, and continued to be, their property; as such these improvements, houses, barns, fences, and what not, had entered into no calculation of the Government's when buying and selling.

Since the act went into operation a good many tenant-purchasers have sold out their holdings, and, considering the value of their improvements, usually at a marked advance on the purchase price, bearing out to some extent the complaints of the original proprietors that too little had been paid them. It is difficult to arrive at the truth of this much-disputed matter; a fair approximation alone is possible. Wilderness lands bought some years ago from the Government, and still unimproved, sell at a considerable premium. Cultivated farms do not as a rule realize so handsome an advance, and in their prices is to be considered the very variable element of value—tenants' improvements. It is generally thought in the island that something more than the mere sentiment of ownership as distinguished from tenancy was sought to be gratified by the land agitation. For twenty years before 1875 a suffrage practically universal was enjoyed by the island. A voting majority had it in their power to modify the tenure of property in their own interest, and they exercised it through their parliamentary representatives. To-day the effect of a habit of mind acquired in the years during which concession after concession was made to tenants is still plain. Arrears due the Government go on accumulating, it would seem, with the expectation that in the future they may be wiped off the slate. The tenants when they became purchasers had decidedly good bargains; they would certainly not have agitated as they did

merely to exchange rent for an equal financial burden of interest, yet, as events have proved, their bargains, though good, have been less profitable than was anticipated. Since 1875 the vast areas in the far West and Northwest brought under cultivation have greatly reduced the prices of farm produce, and have at the same time powerfully attracted the emigrating classes of the Atlantic seaboard.

Rhetoric, in so far as it prophesied a wonderful impetus to the island when leaseholds gave place to freeholds, has somewhat missed fulfillment. Unthrifty farmers were not born again to thriftiness by the act of 1875. The money-lender has taken the place of the landlord with a good many of them. His terms are not so easy, nor his methods so gentle, and already about a fourth of the farms of the island are mortgaged at rates of interest averaging about seven and a half per cent. A single solicitor in Charlottetown has stowed in his vault mortgages to the amount of half a million dollars, held chiefly by widows and orphans, whose claims, unlike those of the wealthy proprietors, are exigent and must be promptly met.

The lesson from the history of land-proprietorship in Prince Edward Island is applicable to a wider field than the little Canadian province. It marks the unwisdom of governments in granting large tracts to corporations or individuals on nominal terms. With the lapse of years, if holdings are retained by their original grantees, the rise in value is enormous, and a community which has chiefly created that value resents the levy of "unearned increment." The agitation in Prince Edward Island also illustrates how the wide franchises of democracy modify the violence of combats concerning questions of property. Even though the mistakes of the Old World be sometimes repeated in the New, though unwarrantable privileges be created or acquired, the people possess a power in the ballot-box which renders unnecessary those appeals to the cartridge-box which so often accompany transatlantic agitation. Perhaps, when English Hodge awakens to his new influence as a voter, laws partly of his making may take the color of his interests, and English landed property may be further shorn of privilege. Beyond that may also be exerted the sinister influence against contract to which law-makers with little property, or none, are ever strongly tempted.

GENIUS AND PRECOCITY.

By JAMES SULLY.

I.

THE idea that genius reveals itself early in life does not at once recommend itself to common sense. Observation of Nature as a whole suggests, first of all, perhaps that her choicer and more costly gifts are the result of a long process of preparation. And, however

this be, there is certainly more of moral suggestiveness in the thought that intellectual distinction is the reward of a strenuous adolescence and manhood than in the supposition that it can be reached by the stripling at a bound through sheer force of native talent. And it may not improbably have been a lively perception of this ethical significance which fostered in the classic mind so wide-spread a disbelief in early promises of great intellectual power. We find a typical expression of this sentiment in the saying of Quintilian: "Illud ingeniorum velut præcox genus non temere umquam pervenit ad frugem." That is to say, the early blossom of talent is rarely followed by the fruit of great achievement.

It is evident that this saying embodies something like a general theory of the relation between rank of talent and rate of development. Where superior intellectual ability shows itself at an early date, it is of the sort that reaches its full stature early, and so never attains to the greatest height. On the other hand, genius of the finer order declares itself more slowly.

In order to estimate the soundness of this view, two lines of inquiry would be necessary. We should need to ask, first of all, what proportion of those who had shown marked precocity have afterward redeemed the promise of their youth; and, secondly, what number of those who have unquestionably obtained a place among the great were previously distinguished by precocity.

These two lines of investigation are, however, in a measure distinct. It may turn out that a large proportion of clever children never attain to anything but mediocrity in later life, and yet that the majority of great men have been remarkable as children. Hence, we may confine ourselves in the present essay to the second branch of the above inquiry, the retrogressive search for signs of precocity in the early life of those who have attained distinction.

It is to be remarked that even the limited inquiry to which we propose to confine ourselves here is a complex one. It includes, at least, two distinct questions—namely, first, whether men of genius have, in the majority of cases, displayed marked ability at an early age; and, secondly, whether they have reached their full maturity of power and highest achievement early or late. It is specially important to distinguish these two points, because they are apt to be confused under the shifting significance of the word "precocious."

I shall confine myself, then, at the outset to the question how far, or in what proportion of cases, recognized intellectual eminence has been preceded by youthful distinction and superiority to others. And in order to narrow the inquiry still further, I propose to deal exclusively with those who have reached eminence in some branch of art or of literature. This will exclude those who have displayed genius in the region of practical affairs, such as the statesman, the soldier, and the ecclesiastic.

Within the boundaries thus drawn there appear to be seven groups sufficiently distinct and important to require separate examination. These are—1, musicians; 2, painters; 3, poets; 4, novelists; 5, scholars, including historians and critics; 6, men of science; and, 7, philosophers. These classes are marked off from one another partly by differences in the materials and the form of the production, and partly by differences in the intellectual implements employed, such as observation and sensuous imagination.

As indications of precocity we shall select, first of all, any manifestations in childhood or youth of an exceptional aptitude and bent corresponding to the special direction of the later development of the genius. Thus, in the case of the poet, we must note such boyish characteristics as an exceptional love of poetry, a disposition to dreamy abstraction, etc. With respect to evidences of general intellectual ability, such as a high place at school or college, these will have a very different value in different domains. In the case of the musician, for example, they would have little relevance—except, indeed, so far as want of application to the prescribed course of studies might serve as negative evidence of an absorbing interest in the self-chosen study. On the other hand, in judging of the precocity of the scholar the school reputation becomes an important ingredient of the case.

In looking out for evidence of special talent we may, in certain cases, find a number of data ready to hand. Thus, in dealing with a musician, we may consider the age at which executive skill was shown, the date of the first original composition, and, as a valuable supplement to these, the time at which music was seriously taken up as a profession. In the case of other sorts of talent such a variety of data may not be accessible.

Finally, after chronicling all indications of childish and youthful precocity, we have to record the age at which the first great work was achieved, a work that either at the time or later on came to be regarded as a title to fame.

In conclusion, I may say that I have confined the inquiry to modern celebrities. Our knowledge of the lives of ancient writers and artists is, as a rule, too scanty to yield the required data. And, even in the case of some modern men of mark, the want of a record of early years has compelled me to omit the names from my list. I have abstained, too, for obvious reasons, from including the names of living celebrities.

Taking the groups in the order indicated above, we shall, in the case of each class, look first of all for instances of remarkable precocity. We may then go on to inquire into the proportion of precocious to non-precocious members of the class.

Musicians.—The stories of the more remarkable instances of boyish musical talent, alike in execution and in composition, are prob-

ably well known to most readers, so that I may pass them over with a brief reference.

Mozart is, I believe, the true *Wunderkind* in the magical realm of music. He began to play at so infantile a period that no date is assigned. At four he could play minuets, in good style probably, for a year after he was exhibited in public. Early in his fifth year he composed concertos; at eleven he wrote an opera buffa, and so forth. Next to him, perhaps, comes Mendelssohn, who first played in public at the age of nine, and whose first dated work, a cantata, was written when he was eleven. Beethoven tells us that he began music in his fourth year, and that at nine he had outgrown his father's teaching. He is said to have written a cantata when ten, and it is certain that a composition for the piano (variations on "Dressler's March") dates from this year. Schubert is another conspicuous instance of early musical development. He, too, soon outstripped his teacher, who said he had got harmony at his fingers'-ends. At eleven he was sufficiently skillful with the violin to play that instrument in church, and at the same date he began to compose little songs.

The examples just cited illustrate what may be called all-round musical precocity. Others show early talent in a more restricted form of activity. A number of musicians distinguished themselves as lads by masterly execution. Meyerbeer, who as a young child could play any air he had heard, performed at a public concert at nine. Hillier did the same thing one year later. At the age of twelve Spohr played the violin in public. Mehul was installed as organist at ten.*

Among instances of early attempts at musical composition may be named the following: Schumann tells us that he composed before seven; Cherubini is said to have written at nine, Auber at eleven, Weber at twelve (his first opera dates two years later), David at thirteen, Lotti and Rossini at sixteen, and our own Purcell at seventeen.

We have now to note the very early age at which a number of eminent musicians entered on a regular curriculum of study with a view to professional life. Some of the greatest precocities, as Mozart, Beethoven, Schubert, Mendelssohn, etc., having had parents either themselves musical and able to be teachers themselves, or at least sympathetic and anxious to get musical instruction for their gifted children, may almost be said to have begun their professional career from their infancy; others began to study at a very early age. Thus Weber was sent by his father (himself a musician) to be instructed, at the age of nine. Puck began to study at twelve. In many cases we see the young musician's quenchless earnestness aided by the favor of influential friends, leading to an early devotion to the art, even in the teeth of parental indifference or active opposition. Handel and Haydn are striking cases in point.

* Two living musicians are remarkable instances of precocious executive talent: Rubinstein played the piano in public at ten, and Liszt at twelve.

I have here selected some of the more striking instances of musical precocity. But the question still remains, What proportion of eminent musicians showed marked taste and ability as children? In order to answer this question I have gone through forty names. Of these I find that thirty-eight displayed a decided bent to the art before twenty. This is expressly stated in most cases, and in the rest is clearly inferred from the date of study, or of the first musical composition. The two excepted names are those of Palestrina and Tartini. Of the early life of the former little is known; but it is fairly inferable that he took up music in his youth. Tartini is the only instance I have met with of a first impulse to music showing itself after twenty. He is said to have first taken up the violin to relieve the monotony of cloister-life. But the story has a suspicious touch of romance about it.

Of the thirty-eight who were precocious to the extent just defined, I have ascertained that twenty-nine are said to have shown a musical gift as children. There is some reason to suppose that others betrayed musical skill toward the end of childhood (about twelve). So far as I can discover, only in the case of two of the nine exceptions is there reason to conclude that there was no marked manifestation of ability in childhood. These are (an odd juxtaposition) Rossini and Wagner. The former, says Brendel, though early subjected to musical discipline by his parents, themselves musicians, showed himself at first indocile and disinclined (*abhold*) to the art. Only in his seventeenth year does this distaste appear to have given way to genuine devotion. R. Wagner tells us that as a child he was not specially attracted to music, and that it was only when, at the age of fifteen, he made the acquaintance of Beethoven's symphonies, that he became inspired by a strong and overpowering passion for the art.

The date of a first musical composition is less easily obtainable than that of a first literary publication. I have managed to ascertain it in twenty-seven instances. Out of these, ten began to compose before the age of fifteen, fourteen more between fifteen and twenty, and only three after twenty.

If, now, we go on to examine into the age at which musical composers gave a distinct pledge of their greatness by a work of undoubted excellence, or at least of such merit as to win public recognition, we find much greater diversity. In some cases of early production the quality of the work was striking in itself and apart from the age in which it was produced. This applies to some of the most marvelous instances of precocity. Thus, Mozart, after gaining renown as a wonder-child by his symphonies, sonatas, etc., proceeded rapidly to lay the foundations of a lasting fame by operatic compositions. At the age of fourteen he acquired great popularity in Italy as an opera-writer, and by his nineteenth year had struck out his own original line in the opera, "La bella finta giardiniera." Mendelssohn was no less agile in

climbing the difficult height of fame. His early creative activity has the same exuberance, the same prodigality as that of Mozart, and the quality of this early production may be seen in the fact that he was only seventeen and a half years old when he composed the well-known overture to the "Midsummer-Night's Dream." The development of Schubert's genius exhibits a similar velocity of movement at the outset. After trying his hand at smaller compositions he essayed a symphony in his seventeenth year, and a few months after produced his first mass—a work, says Sir G. Grove, which is as striking an instance of early ripeness of talent as Mendelssohn's overture.

If we compare with this rapid upward movement the early course of Beethoven's genius we see a marked difference. If, says the authority just quoted, we compare what this composer had done by twenty-two with the abundant productivity of the three others by the same age, we have to pronounce the works to be few and unimportant. He has to show against Mozart's thirty-six symphonies only one, and against the same writer's twenty-eight operas, cantatas, and masses, nothing at all. It was not till the age of twenty-five that Beethoven published works of high importance (including the first three sonatas for the piano, and the song "Adelaide"). And he first attacked large compositions, quintets for strings, symphonies, etc., in his thirtieth year.

Backwardness in original musical production is exemplified by two writers of opera, Gluck and Wagner, both of whom began as imitators of others, and only struck out a new path in middle life. Another example is Sebastian Bach, who did not compose till after forty. But perhaps the most noteworthy instance of late musical development is Haydn, who, though he gained a certain limited reputation in his youth, did not divulge the secret of his great powers till toward the age of sixty.

Nevertheless, in spite of these inequalities, it may be safely said that, as a rule, the great musical composers have redeemed the promise of a precocious youth with a creditable alacrity. This may be seen by a glance at the following figures: Out of thirty names selected for examination, I find that eighteen unquestionably reached eminence under twenty-five, or twenty-two in all under thirty; leaving eight who attained fame after thirty. Thus about three fifths of the illustrious names in the history of music came into possession of their full intellectual heritage on, or soon after, attaining their majority.

PAINTERS AND SCULPTORS.—The history of art is so rich in illustrations of precocity that it is difficult to select the best examples. Mantegna showed such marked ability as a child that he was taken up by a patron and entered by his master in the guild of painters before the completion of his eleventh yoar. Again, Andrea del Sarto is said to have shown fondness for drawing as a child, and at the early age of seven to have been introduced to the world of art in the shop of a goldsmith. Raphael seems to have been a painter from the cradle. He

was sent to learn of Perugino when twelve years old, and at seventeen was painting on his own account. Tiziano showed as a child a decided preference for art over classics, and painted at the age of twelve a Madonna and Child in the tabernacle of a house, and about two years later studied under Gentile Bellini. Tintoretto used as a child to draw on the walls of his father's house, and received the name by which he is most widely known at this early date. Hardly less striking in his precocity is Michael Angelo, who as a lad kept running off to the studios, and at fourteen was received by Ghirlandajo as a regular pupil.

Turning from Italy we meet with no less interesting illustrations of artistic precocity. Murillo displayed talent as a child, covering the walls of his house with his drawings. It is said that he painted pictures as a boy and sold them at the fair. Holbein, who was taught at an early age by his father, painted finished pictures by the age of thirteen. Ruysdael is said to have painted notable pictures at twelve. At the same age Cornelius painted original compositions in the cathedral at Neuss, which show great talent. Vernet helped when a boy to paint his father's pictures. Ary Scheffer, the son of a painter, painted from early childhood, and exhibited in the Amsterdam Salon at twelve.

Among sculptors, Canova is said to have carved a lion at twelve. Thorwaldsen entered on a regular course of study at eleven.

Coming to our own country, we find instances of precocity which equal, if indeed they do not surpass, those furnished by other countries.

Perhaps the most remarkable instance is George Morland. He is said to have taken to pencil and crayon almost as soon as he left the cradle. Sketches of his made at the age of four, five, and six, were exhibited to the Society of Artists, and won praise for the child-artist. Sir Thomas Lawrence was another childish marvel. As a small boy he could draw portraits, and at nine not only copied historical paintings in a masterly style, but succeeded in compositions of his own. At ten his childish fame was such that he was sent by his father to Oxford to paint bishops, earls, and other notabilities—an experiment which brought great gain to his impecunious parent. At seventeen the period of his riper and more lasting fame commenced. With these instances must be reckoned Landseer, who, taught by his father, could draw well at five, and excellently at eight. When only thirteen he drew a majestic St. Bernard dog which was etched by his brother, and in the same year pictures of his appeared in the Royal Academy under the name of Master E. Landseer. Gainsborough was a confirmed painter at twelve. Turner, though hampered by poverty, made such progress that he exhibited at fifteen. Wilkie says he could draw before he could read, and he exhibited at fourteen. Flaxman amused himself when a sickly child by drawing in crayons, and exhibited busts at fifteen.

Reference has already been made to the early age at which artists have seriously taken up art as the work of their life. In many cases this date alone sufficiently attests the presence of childish gifts. Two great Italian painters, Perugino and Tiziano, are said to have studied painting at nine. Correggio is known to have begun his studies before thirteen. Van Dyck was taken in hand by his father at eleven. Rubens, to the distress of his mother, who was ambitious for what she deemed a higher career for her son, was sent to learn painting at thirteen.

Following the same method as that pursued in the case of musicians, we may now seek to give numerical precision to our investigation. I have taken fifty-eight artists, consisting of painters, sculptors, and architects, of whose early years I have been able to obtain any information. Of these I find that forty-two, that is to say, about three out of every four, are credited with having shown a decided skill before the age of fifteen. Or, if we take the age of twenty as our limit, we have forty-seven, or about four out of five, instances of precocity. To this it must be added that in eight cases, not included here, we are told that the artist showed talent, or attained distinction, early in life. And we may perhaps safely include one half of these under the head of manifestations of talent before twenty. By so doing we should raise our proportion to $\frac{46}{58}$, or about eight out of nine.

With respect to the date of the first completed work, I have been able to collect a fair number of facts. Thus, out of forty-two cases inspected, nine produced work before fifteen, sixteen between fifteen and twenty, fifteen between twenty and twenty-five, one between twenty-five and thirty, and one after thirty.

If now we inquire into the age at which real distinction was attained, and the first fruits of a permanent reputation reaped, we find, in general, that this date accords with the very early indication of taste and skill. In the case of more recent artists, we have, among the data which point to early eminence, the winning of academical prizes, and admissions to the walls of exhibitions. Instances of early prize-winners are Thorwaldsen, Ingres, and Wilkie. Reference has already been made to the early age at which Ary Scheffer, Morland, Turner, and Landseer, succeeded in getting their works exhibited.

In many instances we know that the artist made his mark in youth, or very early manhood. Mantegna painted pictures of exceptional excellence at seventeen. Fra Angelico was a skilled artist at twenty. Another early Italian artist, Orcagna, had fully established his reputation about the age of twenty-two. Ghiberti attained notoriety by his successful design for the bronze doors about twenty-one or twenty-two. Coming to later workers, we find it recorded that Leonardo painted finished pictures at twenty. Michael Angelo produced great works by nineteen. Raphael painted fine pictures at twenty-one. Titian became a distinguished painter at about twenty. Correggio

struck out his original manner about eighteen, and reached fame soon after twenty. Holbein is known to have painted good works at the age of fifteen, and at nineteen produced fine examples of finished portraiture. Van Dyck, too, painted exquisite portraits at twenty-one. Rubens had made his mark by excellent work at twenty-three. Rembrandt was famous at twenty-four, and about the same age Velasquez won royal recognition. Vernet painted considerable works at twenty-two. In our own country Landseer is again one of the most striking examples. By the age of eighteen he had won recognition as a great artist, and had more work than he could do. Lawrence was about the same age when he established his reputation as a finished painter. Turner painted pictures at eighteen which display real power. Reynolds had won a European reputation by twenty-three, and Romney's finer work dates from about the same age.

Here again figures may be useful. Out of a list of forty-two about the date of whose attainment of fame-bringing excellence I have been able to inform myself, twenty-eight reached this point before twenty-five, nine more before thirty, and the rest soon after that date. I can not find an instance of artistic fame having been reached after the age of forty.

A word or two may suffice respecting the few exceptions to the rule of the early manifestation and rapid growth of artistic genius. In one case, that of Ghirlandajo, we are explicitly told that distinction was not reached till after thirty. In another, that of Francia, I have gone by the fact that the earliest dated work belongs to the age of forty. Perhaps the most striking example of an undoubtedly late bloom of artistic genius is that of Sir Christopher Wren. He first distinguished himself in the realm of science (particularly mathematics and medicine), and suddenly showed himself a great architect about the age of thirty.

Poets.—A goodly collection might be made of stories of famous poets who have "lisped in numbers." I mention a few of the more interesting cases.

Among the great Italians Tasso is perhaps the most conspicuous example. Wonderful anecdotes are related of his childish powers. In his seventeenth, or at the latest in his eighteenth year, he wrote "Rinaldo," a work which instantly brought him renown. Gordoni, the comedian, showed his bent as an infant by choosing puppets for his playthings, and he astonished his friends by knocking off a sketch of a comedy at the age of eight. Metastasio, as a child, improvised in the streets, holding a crowd in admiring attention, and translated the "Iliad," at twelve. The great Spanish dramatist, Calderon, is another clear instance of precocity. His development was so rapid that at the age of thirteen he went to the high-school at Salamanca, and at fourteen wrote his first play. Among German poets, Goethe, the greatest, is also the most precocious. He is said to have composed dialogues

between six and eight. His first poems date from the sixteenth year, and by twenty-two he sounded in his "Götz von Berlichingen" the new national note in German drama. Among French poets Alfred de Musset, who had excited the envy of his comrades at school by his quickness, composed poems at fourteen. Perhaps, however, the most valuable example among French poets is Victor Hugo, who was called an "enfant sublime," began as a school-boy to write poems, both translations and original compositions, by sixteen produced finished works of lasting value, and by twenty-five was the acknowledged leader of the Romantic movement.

Among our own poets one can find instances of precocity which in no wise fall behind those just quoted. Beginning with the sixteenth century we have Beaumont, who was called by Wordsworth the eager child, and who seems to have composed tragedies at the age of twelve. Next comes the name of Cowley. In his tenth year he wrote an epical romance, which, according to an eminent living critic, though marked by faults of immaturity, is enriched by considerable merits, and is "the most astonishing feat of imaginative precocity on record." He followed up this first effort so well that he was famous before fifteen. Coming to the last century the name of Pope at once arrests our attention. When a child he was a skilled satirist. At twelve he took upon him the responsibilities of self-tuition, and at the same age produced what have been described as the "beautiful and touching" stanzas on "Solitude." Of the present century poets Byron and Coleridge are the most famous examples. Byron, who was deeply in love before ten, wrote before fifteen poems which bear the stamp of genius, and by twenty-one made himself famous by his brilliant satire, "English Bards and Scotch Reviewers." Coleridge was "filled with poetry and" (odd assortment) "metaphysics" at fifteen; and at sixteen he had produced poems bearing the unmistakable marks of genius.

Our poetesses do not lag far behind their brothers. At least we have two names to set against the list of male precocities. One of these, indeed—Elizabeth Barrett Browning—ranks among the phenomenal instances of early intellectual prowess. At eight she read Homer in Greek, and at the same age began to write poetry. At eleven or twelve she wrote an epic, which her father printed. And before fifteen she produced works which attest true genius.* Mrs. Hemans, the other poetess referred to, was a clever, self-taught child, and published a volume of poems at the age of fourteen.

In order to ascertain what proportion of the world's singers gave early promise of their vocal powers, I have gone through fifty-two records of modern poets. Of these, thirty-nine, that is to say three out of four, were distinctly precocious. Many of them began to versify in early youth. A large proportion betrayed as children a strong

* I am indebted to Mr. Leslie Stephen for some of the facts relating to Mrs. Browning.

bias to dreamy contemplation and solitude. In respect of methodic learning, a good number, if not the majority, appear to have been sadly wanting.

Poets rank high, too, in the matter of early production. After going through a series of sixty names, I find that thirty-eight, or very nearly two thirds, wrote before twenty. Of the others, seventeen began to write before thirty. Thus only five, that is to say, one out of every twelve, took to poetic composition after thirty.

The plant of poetic genius is not only early in disclosing its young shoot, but grows rapidly to the stature that commands admiration and renown. In some cases, as those of Tasso, Goethe, Coleridge, Campbell, and Moore, recognition follows almost instantaneously. In a much larger number, including Milton, Pope, Byron, Keats, and Voltaire, fame is reached after a very few years.

After examining forty-nine cases, I find that twenty-eight, or four out of seven, won renown by the age of twenty-five. The proportion of those who were famous by thirty is thirty-six, or more than five out of seven. Finally, forty-five, or nearly thirteen out of fourteen, had attained fame before forty, leaving only four who attained this point later in life.

Turning now to our list of exceptions, it is to be observed that in some cases—e. g., Chaucer, Marlowe, and Corneille—the record of early life is too meager to allow of our being sure that there were no manifestations of precocity.* One of our exceptions, indeed—Dante—appears to have shared with Byron a precocious development of the sexual emotion. But, allowing for uncertainties, there is a clear residue of cases in which the gift of poetic utterance revealed itself late. Camoëns, Racine, Goldsmith, Cowper, Wordsworth, may be cited as examples. The last two poets, together with Dryden and Dante, make up the four who missed renown till after forty. Of these, Cowper appears not to have begun to write till after that age. Dante, like Milton, passed his early manhood in the service of the state. Dryden and Wordsworth began to write when young, and so are signal examples of a long, unrewarded fidelity to the Muse.†

Novelists.—Among writers of fiction we find a number who displayed imaginative power in early life. Scott, who was at the University of Edinburgh at twelve, neglecting the regular academic studies for romances, began about this date to practice the invention of stories with a college friend. Dickens is a more impressive instance still. Forced, when a child of nine, to go out into the world and earn his livelihood, he indulged his irresistible bent to fiction not only by a

* Much the same remark applies to Shakespeare, whose first poetic effort I have set down as dating from his twenty-eighth year.

† The Greek and Latin poets supply several alleged instances of precocity. Living poets seem, as far as I can judge from the date of their first publication, to be somewhat below the average in this respect.

vivid realization and reproduction of the creations of others, but also by original inventions, the recital of which brought the lad a high renown among his companions, and, spite of poverty, he succeeded in publishing his first novel by the age of twenty-two. Another striking instance is Lytton, who published poems at fifteen and produced his first novel by twenty-two. Among foreign novelists we have Balzac, who, when a schoolboy, excogitated a theory of the will, and began to publish novels soon after twenty; and Hoffmann, who was a marvel of boyish cleverness, and who began to write novels soon after leaving school.

Among lady novelists instances of precocity are Charlotte Brontë and her sister, who, as soon as they could read and write, began to invent and act little plays of their own. By the age of fourteen Charlotte had put together a number of stories as well as poems and plays. But it was not till the age of thirty that she prepared her first considerable novel, "The Professor." Emily, who was two years younger than her sister, completed her "Wuthering Heights" about the same time. Another instance is Miss Burney. As a child she was remarkable; she taught herself to read and write, and became an incessant scribbler of verse and prose. She was not much more than fifteen when she planned the story of "Evelina," though it was not actually written till some years later, and only published when she was twenty-six.

Taking twenty-eight novelists, I find that in twenty-one cases, that is, in three cases out of four, there is evidence of imaginative power showing itself before twenty. Sometimes this evidence is of a curious character, as in the case of Richardson, who at the age of thirteen displayed his skill in letter-writing by acting as confidential secretary to three of his girl acquaintances, inditing or correcting their answers to the epistolary effusions of their lovers.

Novelists exhibit much diversity of habit with respect to the date of their first appearance before the public. In a list of thirty-two names two published their first work before twenty; seven between twenty and twenty-five; nine between twenty-five and thirty; seven between thirty and forty; and seven after forty. It may be observed that names of world-wide reputation appear in each group except the first. Thus Dickens and Hawthorne fall under the first of the four divisions; George Sand, Thackeray, and Victor Hugo under the second; Fielding, Goldsmith, and George Eliot under the third; and Defoe, Richardson, Sterne, Scott, and Cervantes under the last.

The date at which the first notable work appears varies in very much the same way. In a series of thirty-one names, three produce a work of note before twenty-five; nine more before thirty; twelve more before forty; and seven after forty.

The most remarkable examples of late development are Defoe, who, after devoting the best part of his life to political polemics, suddenly

struck into the path of fiction at the age of forty-four, and only gave his "Robinson Crusoe" to the world eleven years later; Richardson, who published his first fiction when fifty-one; Sterne, who, after passing many contented years in the seclusion of a country rectory, tried his luck as a novelist by publishing "Tristram Shandy" at the age of forty-six; and Cervantes, who, after years of active service, followed out an early impulse to letters in his thirty-sixth year, and produced his masterpiece at the mature age of fifty-seven.

SCHOLARS, HISTORIANS, CRITICS. — In this rather miscellaneous group we have a number of first-rate instances of precocity. Grotius has been pronounced one of the greatest of prodigies in this respect. At nine he wrote good Latin verses; at twelve he was ripe for the university; at fifteen he was editing the encyclopedic treatise of Capella; and at seventeen did excellent scholarly work. Our own Porson, the son of a parish clerk, at a very early date attracted notice by his exceptional powers of acquisition. At nine he could extract the cube root of a number by a process of mental arithmetic. Before fifteen he was able to repeat the whole of Horace, Virgil, and many parts of Livy, Cicero, etc. His productive work began later (twenty-four). Niebuhr resembles Porson in being the son of poor parents, and having a predilection at first for mathematics. At seven he was regarded as a marvel of boyish erudition. Among our own historians, Macaulay and Thirlwall are distinguished by precocity. Macaulay, whose extraordinary power of retention is well known, showed a decided bent toward literature as a child. Before eight he had given a presage of his historical work by putting together a compendium of universal history. By the same date he had written a romance, and soon after composed long poems. Thirlwall is a still more wonderful example. The son of a clergyman, he was taught Latin at three, and by four could read Greek with a fluency which astonished his family. He began to write at seven, and at twelve appeared before the world in a volume entitled "Primitiæ," which contained essays, and poems on various subjects, grave and gay. Soon after twelve, when at Charterhouse, he wrote elaborate letters in Latin, showing extraordinary reading and critical judgment.

If now we inquire what proportion of the class were distinguished for intellectual precocity, we reach the following results: Out of thirty-six cases, thirty, or five sixths, are said to have been distinguished by preternatural ability, either in childhood or in early youth. So far as I can ascertain, about one half of these betrayed at an early age the precise direction of their future mental activity. This applies, for example, to Gibbon, De Quincey, Hazlitt, and Lessing. The others either proved themselves quick all-round learners, or evinced exceptional intellectual strength in some other direction—e. g., mathematics or poetry.

It becomes a very different question if we inquire into the age at

which original production commenced. Out of a list of thirty-five it would seem as if only seven—that is, just one fifth—published before twenty. Eighteen more commenced their literary career between twenty and thirty; four more between thirty and forty; leaving six who began to write after forty.

With respect to the age at which a position of eminence is reached, our present group shows still wider variations than the previous ones. An inspection of a series of thirty-five writers gives the following results: only seven, or one fifth, won distinction before twenty-five; nine more before thirty; sixteen more before forty; leaving three unrewarded till after this date.

I may add that where—as often happens in the case of scholars and historians—a wide reputation is at once secured by a masterpiece, the appearance of this commonly falls in the thirties at the earliest. Niebuhr's first volume was published when he was thirty-nine; Thirlwall's when he was thirty-eight; Grote's, though conceived about thirty, not till fifty-two. On the other hand, literary critics—as Addison, Diderot, Lessing—have frequently obtained recognition by some excellent piece of work before thirty.—*Nineteenth Century.*

[*To be continued.*]

THE PROGRESS OF PSYCHICAL RESEARCH.

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THERE was a time when philosophy might have been defined as the science of human activity, so all-comprehensive was it. The ambitious Greek who would attach his name to a philosophical system must include in his scheme all that could be known, done, and speculated about God, the world, and man. In the course of time and the specialization of the sciences this view of philosophy fell away, and was replaced by the more exact and narrower conception of modern times.

But it is a question whether science, particularistic in its early history, is not aiming to reach the position which philosophy has retired from. If we take science to mean classified knowledge, then this increase of its field is but natural, and marks the progress of man's domination over the external world.

The last bit of territory which science has invaded, and which, in time, it hopes to claim for its own, is an especially interesting one; and, in response to the many inquiries, credulous and skeptical, which are raised, both in public and in private, we wish to give a brief sketch of the progress which science has thus far made in its new field.

As far back as our records reach—perhaps, as Mr. Spencer thinks, from the childhood of our race—a belief in the existence of invisible and, on physical grounds, unexplainable beings and modes of action has existed in human society. Sometimes this belief has dominated a larger, sometimes a smaller portion of mankind, and the attitude of the intelligent classes toward it has correspondingly varied. In our own day this belief not only exists, but it influences a far greater number of persons than the chance observer supposes.

Of late years the effects of this belief in supersensible beings and influences have shown themselves in many ways and places, particularly in Great Britain and America. We have heard of numberless clairvoyants, spiritualists, mesmerizers, and mind-readers. The nineteenth-century scientist has hitherto found no leisure to investigate the many remarkable occurrences that, from time to time, have been spoken and written of; or, if he has had the leisure, he has spurned the reports of these occurrences as beneath his notice as an educated and well-balanced man. Nevertheless, the fact that such occurrences as we refer to, numerous instances of which are familiar to every one, have been allowed to pass uninvestigated, has been a standing reproach to true science. Science prides itself on dealing with phenomena of any kind whatsoever, without fear or favor. And these occurrences, and the belief which many intelligent men and women hold in reference to them, are certainly phenomena. Grant, for the sake of argument, that the occurrences are fictitious and fraudulent, the belief in them remains as a phenomenon in human nature. Instances of this form part of our experience quite as truly, if not so frequently, as the sensations of heat and light do. If they are false, let us know the fact on demonstrable grounds; if true, let us know how and why. At all events, we must have scientific knowledge concerning them.

If this investigation is to be scientific, it must be undertaken in a thoroughly impartial spirit. We must lay aside our preconceived notions, and examine the facts as we find them. We want to know the truth, the whole truth, and nothing but the truth.

About four years ago certain gentlemen in England, all of them well known in their respective callings, found that they held substantially the opinions which we have just outlined, and the result was the formation of a Society for Psychical Research. It is to the work of this society that we desire to call attention.

The *personnel* of the society is remarkable, and of a character to command the greatest respect and confidence. The first president was Henry Sidgwick, the distinguished Professor of Moral Philosophy at Cambridge, and on the list of the earliest officers and council we find such names as those of Professor Balfour Stewart, Professor Barrett, of Dublin, Richard H. Hutton, Edmund Gurney, and F. W. H. Myers. That the principle and work of the society continue to inspire confidence may be inferred from the fact that, since its organization in

1882, the society's membership has increased to almost one thousand, and on its roll we find the honorable names of Gladstone, Ruskin, Tennyson, Earl Russell, Lord Rayleigh, the Bishop of Carlisle, the Bishop of Ripon, John Addington Symonds, Canon MacColl, and scores of others distinguished in politics, literature, and science.

That a thoroughly scientific spirit is actuating the society's work will be seen by an extract from its official publications. At the time of organization we read: "It has been widely felt that the present is an opportune time for making an organized and systematic attempt to investigate that large group of debatable phenomena designated by such terms as mesmeric, psychical, and spiritualistic. From the recorded testimony of many competent witnesses, past and present, including observations recently made by scientific men of eminence in various countries, there appears to be, amid much illusion and deception, an important body of remarkable phenomena, which are, *prima facie*, inexplicable on any generally recognized hypothesis, and which, if incontestably established, would be of the highest possible value. The task of examining such residual phenomena has often been undertaken by individual effort, but never hitherto by a scientific society organized on a sufficiently broad basis."

The field for operation was so extensive that there was naturally some difficulty in determining the point of beginning work. But, after due consideration, the following programme was drawn up, and a special committee was intrusted with each of the six subdivisions of the society's work:

"1. An examination of the nature and extent of any influence which may be exerted by one mind upon another, apart from any generally recognized mode of perception.

"2. The study of hypnotism and the forms of so-called mesmeric trance, with its alleged insensibility to pain; clairvoyance, and other allied phenomena.

"3. A critical revision of Reichenbach's researches with certain organizations called 'sensitive,' and an inquiry whether such organizations possess any power of perception beyond a highly exalted sensibility of the recognized sensory organs.*

"4. A careful investigation of any reports, resting on strong testimony, regarding appearances at the moment of death, or otherwise, or regarding disturbances in houses reputed to be haunted.

"5. An inquiry into the various physical phenomena commonly

* The phenomena described by Baron Karl von Reichenbach (born 1788) were these: Certain persons declared to him that ordinary magnets, crystals, the human body, and some other substances were to them self-luminous, presenting singular appearances in the dark, and otherwise distinguishable by producing a variety of peculiar sensory impressions—such as anomalous sensations of temperature, bodily pain or pleasure, unusual nervous symptoms, and involuntary muscular action. These are generally (but Reichenbach believed not necessarily) accompanied by abnormal physiological and mental states.

called spiritualistic, with an attempt to discover their causes and general laws.

"6. The collection and collation of existing materials bearing on the history of these subjects.

"The aim of the society will be to approach these various problems without prejudice or prepossession of any kind, and in the same spirit of exact and unimpassioned inquiry which has enabled science to solve so many problems once not less obscure nor less hotly debated. The founders of this society fully recognize the exceptional difficulties which surround this branch of research, but they, nevertheless, hope that, by patient and systematic effort, some results of permanent value may be obtained."

In accordance with this programme, the society went to work. Generous donations of money were received, and there were numerous accessions to the membership. It is a mistake to suppose that membership in the society implies anything more than a genuine scientific interest in the investigations. The constitution of the S. P. R., as it is popularly known in England, expressly states that membership in the society "does not imply the acceptance of any particular explanation of the phenomena investigated, nor any belief as to the operation in the physical world of forces other than those recognized by physical science."

Notwithstanding all these precautions, it was asserted in many quarters that the society had in view a particular explanation of the phenomena it was investigating. Professor Sidgwick, in his first presidential address, commented upon the criticisms passed upon the foundation of any such society, and succinctly explained and defended its course of action. In this address, Professor Sidgwick had occasion to define what the society meant by "sufficient evidence" for the phenomena with which it proposed to deal, and he declared that "sufficient evidence is evidence that will convince the scientific world, and for that we obviously require a good deal more than we have so far obtained." In the face of this, it is plain that Professor Ray Lankester's comment, "puerile hypothesis," would have been more in the nature of a scientific judgment had it been delivered after a review of the testimony, and not before.

From the date of organization until the present time the council and committees of the society have labored assiduously. Facts were the great desideratum, and they have been looked for in every conceivable place. Records of experiences were invited from any and every quarter, and many thousands have been received. It is characteristic of the society's method that no story has been accepted as genuine on newspaper testimony, or on second-hand evidence of any kind. In each case places and dates were verified, and the persons directly concerned sought out. As might be supposed, a very large proportion of the stories received were either wholly or partly ficti-

tious, or else grossly exaggerated. The writer's experience in collecting evidence in the United States for the society has been that from eighty-five to ninety per cent of all the stories received were not in accordance with fact. Some appear to be absolute inventions, but the vast majority are made up of a halo thrown by vivid or excited imaginations around some very commonplace occurrence. In one case, General O. O. Howard was given as authority for a very remarkable case of apparition at the moment of death. Names and dates were given with great exactness, and the story was followed up with interest. The result proved that neither General O. O. Howard, nor any one of several others of the same name, who were applied to under the supposition that the initials were wrongly given, knew anything about the alleged occurrence.

This sifting process is in itself valuable, for it places in the realm of fiction much of the current spiritualistic literature, and the attention of the society is concentrated on the residual and duly substantiated phenomena. Moreover, it must be borne in mind that science demands an answer to its questions, and has no regard for the character of the answer. So an answer "No" to a scientific query is of quite as much scientific value as an answer "Yes," though it may fall far below the latter in interest. A fact gained counts one, no matter whether it is positive or negative.

The second method pursued in these investigations has yielded more exact and interesting conclusions than the one just mentioned. The society has directly experimented with persons supposed to possess the power of thought-reading, mesmerizing, and hypnotizing, and as a result has accumulated a great mass of very valuable information.

The committee charged with the investigation of thought-reading, or *thought-transference*, as the society prefers to call it, has undoubtedly made the most progress up to this time. Phenomena falling under this head were divided into four classes: (*a*) where some action is performed, the hands of the operator being in gentle contact with the subject of the experiment; (*b*) where a similar result is obtained with the hands *not* in contact; (*c*) where a number, name, word, or card has been guessed and expressed in speech or writing, without contact, and apparently without the possibility of the transmission of the idea by the ordinary channels of sensation; (*d*) when similar thoughts have simultaneously occurred, or impressions been made, in minds far apart. Of these classes, (*a*) and (*b*) are set aside entirely, for, as has been shown by Dr. Carpenter and others, unconscious muscular actions and unconscious and almost imperceptible indications of various kinds account for any results obtained in these ways. With (*c*) it is very different. Here, to be sure, collusion and risk of error are very difficult to guard against, and in a general company would almost certainly be present. But it is otherwise if repeated experiments be made by a limited number of scientific men well known to

each other. It was in this way that the society's experiments were conducted.

The most satisfactory results were obtained from the family of a Mr. Creery, a clergyman in Derbyshire, four of whose children—girls whose ages ranged from ten to seventeen, thoroughly healthy, and as free as possible from morbid or hysterical symptoms—were reputed to possess the power of being able to designate correctly, without contact or sign, a card or other object fixed upon in the child's absence. To this family the committee made several visits of several days' duration, and the record of their numerous experiments appears to be absolutely unexceptionable and conclusive, as far as it goes. The active members of this committee were Professor Barrett and Messrs. Gurney and Myers.

Sometimes the inquiry took place at Mr. Creery's house, sometimes at the lodgings of the committee. Their plan was to select at random one child, who was then asked to leave the room and wait at a distance, while they chose a card from a pack, or wrote on paper some number or name which occurred to them at the moment. Sometimes, though not invariably, this was shown to the members of the family present in the room; but no one member was always present, and on many occasions the members of the committee were entirely alone. The child was recalled, it having been made certain that she was at some distance when the number or card was selected. This, too, was an unnecessary precaution, as the habit was to avoid any utterance of the chosen card or name. The child was simply told before leaving the room, "This will be a card," or "This will be a name," as the case might be. On re-entering, she stood in any position she chose, though sometimes, at the committee's direction, with her face to the wall. She was silent for a period ranging from a few seconds to a minute, and then called out some name or number, or whatever the subject chosen was to be. If her answer was correct, the committee said "Right," if not, "No," and a second and sometimes a third trial was allowed.

In the case of a card, the chances are fifty-one to one against the successful guessing of any particular card, assuming that there is no such thing as thought-reading, and that errors of experiment are avoided. Yet, in one case of fourteen trials, *nine* were guessed rightly the first time, and only three trials can be described as complete failures. Some of the trials that resulted in what may be called partial successes are extremely interesting, and we give a short selection from the committee's record. The card selected is given in italics, the guesses in Roman type, and the only remarks made (those of the committee) in parentheses:

Five of clubs. King of hearts (No). Five of clubs (Right).
Two of spades. Two of spades (Right).
Three of spades. Three of hearts (No). Ace of spades (No).
Eight of spades. Eight of clubs (No). Eight of spades (Right).

Knave of hearts. Knave of hearts (Right).

Two of clubs. Two of clubs (Right).

King of spades. King of clubs (No). Knave of clubs (No). King of diamonds (No).

Knave of diamonds. King of diamonds (No). Knave of diamonds (Right).

It will be noticed that often the number of the card is guessed rightly, but not so the suit, and *vice versa;* and these partial successes are perhaps destined to be as important in drawing conclusions from the phenomena as those in which the guess was completely successful. In the above cases, the partial successes would seem to suggest a *mental eye*, so to speak, whose vision was in these cases obscured and inaccurate. Other cases, when the objects chosen were names, such as the guessing of Jobson for Johnson, would in a similar way suggest a *mental ear.*

As the result of six days' investigation with this family, 382 trials were made. In the cases of letters of the alphabet, of cards, and of numbers of two figures, the chances against success in a first trial were, of course, 25 to 1, 51 to 1, and 89 to 1 respectively; in the case of surnames they would be indefinitely greater. Cards were most frequently employed, and the odds in their case may be taken as a fair example. If this be done, then, in 382 trials, 7½ would be about the average number of successes on a first trial by an ordinary guesser. In these tests of the committee, 127 trials were successful on a first attempt, 56 on a second, and 19 on a third—202 in all.

The most striking success was when five cards in succession were named correctly on a first trial. The chances against this were considerably over one million to one. By way of precaution, the committee says in its report: "The phenomena here described are so unlike any which have been brought within the sphere of recognized science as to subject the mind to two opposite dangers. The hypotheses as to how they happen are confronted with equally wild assertions that they can not happen at all. Of the two, perhaps the assumption of an *a priori* impossibility is, in the present state of our knowledge of nature, the most to be deprecated, though it can not be considered in any way surprising."

We have given the data of this Creery case at some length, because it illustrates so admirably the methods of the society and the phenomena which it is investigating. In this and similar investigations, the question which the committee had before it was this: Is there, or is there not, any existing or attainable evidence, that can stand fair physiological criticism, to support a belief that a vivid impression or a distant idea in one mind can be communicated to another mind without the intervening help of the recognized means of sensation? And, if such evidence be found, is the impression derived from a rare or partially developed and hitherto unrecognized sensory organ, or has

the mental percept been evoked directly without any antecedent sense-percept?

Space will not permit me to more than mention the nature of the evidence which the society has collected for the purpose of answering these questions. Experiments have been made, and repeated again and again in order to reduce to a minimum all chances of collusion and error. Sometimes contact between the agent and the percipient has been permitted, and sometimes not.* Much of the evidence is very remarkable, but must be read in its entirety to have its full effect, and we refer any inquiring reader to the full reports of the various committees as published in the proceedings of the society.

As a scientific result, the committee felt justified in drawing up the following: 1. That much of what is popularly known as "thought-reading" is, in reality, due to the interpretation by the so-called "reader" of signs, consciously or unconsciously imparted by the touches, looks, or gestures of those present; and that this is to be taken as the *prima facie* explanation whenever the thing thought of is not some visible or audible object, but some action or movement to be performed. 2. That there does exist a group of phenomena to which the word "thought-reading," or, as the committee prefers to call it, *thought-transference*, may be fairly applied; and which consists in the mental perception, by certain individuals at certain times, of a word or other object kept vividly before the mind of another person or persons, without any transmission of impressions through the recognized channels of sense.

Concerning these phenomena, Mr. Myers writes: "We have got, as we hold, a definite fact to start from—a fact of immense and unknown significance. If, as we believe, we can truly say 'mind acts on mind otherwise than by the recognized organs of sense,' this is probably a statement far more pregnant with consequences than the statements, 'rubbed amber attracts straw,' or 'the loadstone attracts iron.' And it must be our business to turn our new fact over in every direction, to speculate upon it in every way, or, rather, in every way which can possibly suggest a new form of experiment. We must remember that the experimental cases which we have already collected are probably only what Bacon calls 'ostensive instances'; 'instances,' as he expresses it, 'which show the nature under investigation naked, in an exalted condition, or in the highest degree of power; and which are, so to speak, mere emergent summits from a great ocean, which lies beyond our present reach of observation, and, perhaps, even beneath the level of our consciousness.'"

As might have been supposed, most progress has been made in this field of thought-transference, for its phenomena are the simplest, and

* The agent is the technical name for the person who concentrates his thoughts upon the chosen object, and the subject or percipient is the person who "reads" the thought, and tells what the object thought of is.

most readily admit of verification or disproof. Still, something has been accomplished in each of the six departments of investigation. The committee having in charge the Reichenbach experiments felt justified in making a report about three years ago, of which the following is the tenor: 1. That three observers separately, on distinct occasions, were in some way immediately aware when an electro-magnet was secretly "made" and "unmade," under such precautions as were devised to prevent ordinary means of knowing, and to exclude chance and deception; and the observers identified such magnetization, with luminous appearances, which, as described, agreed generally with the evidence recorded by Reichenbach. 2. That there were, though less decisively, indications of other sensory effects of magnetism. In view of these apparent confirmations of previous testimony, the committee inclined to the opinion that, among other unknown phenomena associated with magnetism there is a *prima facie* case for the existence, under conditions not yet determined, of a peculiar and unexplained luminosity resembling phosphorescence, in the region immediately around the magnetic poles, and visible only to certain individuals.

The committee on haunted houses has carried on widely extended investigations, despite the fun which the public prints have poked at its "ghost directory," but as yet has not made sufficient advance to warrant a report. It will strengthen our confidence in this committee's work if we recollect that it holds that the unsupported evidence of a single witness does not constitute sufficient ground for accepting an apparition as having a *prima facie* claim to objective reality. Under the operation of this rule, ninety-five of every hundred ghost-stories must fall to the ground.

The investigators of mesmerism are undoubtedly working in a field which has been by no means neglected in the past. They, therefore, have more definite lines of guidance than most of their colleagues. We find that they divide the main phenomena connected with the mesmeric state into three classes: (1) the dominance of a suggested idea; (2) transference of sensations, without suggestion, from operator to patient; (3) induction of general or local anæsthesia. Of these classes the committee pronounces that the first is on the high-road to universal acceptance; that the second is rarely contested, but the committee has added something to the facts already recorded in its favor, and has hope of adding more; that the third class—the production of anæsthesia—has already been established by overwhelming evidence, and is to a certain extent admitted by modern physiologists. But it remains undecided whether this anæsthesia is produced by mere expectant attention, exercised in a particular state of the nervous system, and is thus the culminating example of the dominance of a suggested idea; or, whether it is the result of the inhibition of certain sensory centers in consequence of prolonged stimulation of the peripheral ex-

tremities of the nerves; or, whether it is the result of some specific effluence from the operator, which may act without actual contact, independently of the subject's knowledge or expectation. On the whole, the committee's evidence leans toward the last and antecedently the least probable explanation. But as yet no definite answer is possible on this point.

The literary committee has done very important work, for, in addition to the collection of a considerable library of books on psychical subjects, it has more than one hundred cases, with the evidence taken at first hand, of apparitions closely coinciding with the time of the death of the person seen; and it is only in a small minority of such cases that informants, according to their own account, have had any other hallucination than the apparition in question. While no deduction from this evidence is yet justifiable, yet we may safely agree with Professor Balfour Stewart when he says that "the great importance of this statement will be manifest to all."

There the work stands at present. We have given a brief outline of the objects and method of the society, and have endeavored to make clear just how far its work has progressed. The society is actively at work, the literature of the subject is increasing, and at no distant period more definite conclusions may be laid before the scientific world, and the supporting evidence given at length. That the interest in this work is general is proved by the formation of societies for psychical research in Boston and Chicago, and the character of their officers and conductors is, as is the case in the parent society in England, surety for the careful and scientific prosecution of their investigations. In France too, the psychologists are turning their attention to these phenomena, and men like Janet, Ribot, and Charcot are at the head of a society similar to those we have mentioned.

So far the results are certainly indefinite, but they are interesting and suggestive. The time may soon come when we shall either be able to speak definitely and accurately about these abnormal phenomena, or else to say on demonstrable grounds that their causes and laws lie beyond the limits of human knowledge. Whatever we know will be incorporated in the vast body of scientific truth, and the *raison d'être* of a small army of frauds and impostors, as well as of innumerable superstitions, will have been swept away.

CAUSES OF THE PRESENT COMMERCIAL CRISIS.

By PAUL LEROY-BEAULIEU.

THE whole world has been suffering for two years under an intense commercial crisis. Hardly any country has escaped the stringency. For special reasons, France has suffered the most. But England, Belgium, Italy, Germany, and even the United States and the

South American republics, have not been free from its effects. All kinds of commercial activity bear witness to a universal languor. The railroads show diminished receipts over all the European Continent and in the British Islands. The foreign commerce of France has been declining for five years, during which time the valuation of imports has diminished by sixteen per cent, and that of exports by ten and a half per cent. A part of this decrease is, doubtless, due to the general depreciation of prices, so that the falling off in the quantity of goods handled is not actually so great as the figures would make it appear; but this depreciation in prices is another cause of serious concern to economists. England, also, is struggling against difficulties of a similar character. Italy, where the financial management in later years has been most excellent, has had to pay tribute, though in smaller proportionate amounts, to the general depression. Germany has met a check in the speedy race to wealth which it proudly thought it was making. In the United States the exports have fallen $200,000,000 since 1880. The Argentine Republic, also, is obliged to struggle against grave financial and commercial embarrassment.

We may consider, then, that all nations are afflicted with commercial depression. What are the causes of this universal debility? How long will it last? What remedy can we employ to restore commercial health in the shortest possible time? The opinions as to the origin of the crisis are widely different. Some persons see in it only one of the periodical shocks, one of the "growing pains" which seem to be the accompaniment and price of all progress, and which, coming on in the natural course of events, and having a kind of character of fatality, will disappear of themselves. And some of the people of this class believe they can already see the signs of convalescence. Another class of observers pretend that the present crisis is different from any that have preceded it, that its cause is not natural but artificial, and originated in the mistakes of governments, and that a simple, easily adopted measure of policy will cause its removal at once. These are the partisans of silver, or the bimetallists, as they call themselves. Some attribute the trouble to over-production. Men are producing more than they need. If we do not raise less wheat, make fewer clothes, build fewer houses, everybody will die of hunger, or cold, or want of shelter. This is not a new doctrine, self-contradictory as it is. Then come the protectionists. The mischief is on us because we do not protect enough. All countries are suffering because they buy too much and sell too little. We must protect more. When all the different lands shall have realized that mysterious ideal of selling much to one another without buying in their turn; when they shall, by means of customs duties, have annulled the diversities of productive forces that are derived from nature or from remote antecedents; when they shall have abolished the territorial division of labor among men—the fine days will come again, and prosperous years will

follow one another without interruption. Let us examine these various opinions in succession. We first take up those of the silver partisans; but, without entering into a scientific discussion of the questions at issue, we shall only speak of the actual influence of recent monetary facts on the price of goods and on commerce. There were till recently two metals, sometimes rivals and sometimes allies, contending for and occasionally sharing the monetary function of the world—gold and silver. Each of them had its peculiar territories, and they sometimes spread over into common territories. Gold reigned in England, the United States, and the Scandinavian countries; silver, in the Indies and Germany, and nominally in Austria and Russia; while both metals had undivided sway in France, Italy, Switzerland, Belgium, and Greece, or the countries of the Latin Union, where they had equal legal rights, and were rated in value at fifteen and a half by weight to one—a valuation which M. Cernuschi calls the bimetallic par. This par exists only in some countries, not in all. After the war with France of 1870–'71, Germany changed its single silver standard for one of gold. The Scandinavian states followed suit. France was restrained from following this example by the resistance of the Bank of France, which foresaw ruin to itself in such a measure. The initiative of Germany—although it had failed to make the demonetization of silver complete, as it had intended—coincided with a profound change in the monetary situation of the world. The metal silver began to depreciate and to grow less in value relative to gold. The countries of the Latin Union, being the only ones in which the two metals enjoyed a *condominium* at a ratio of values fixed at the beginning of the century, took alarm at these signs of a widening of the difference in values, and adopted an exclusive standard of gold. The depreciation of silver continued, at an accelerating rate, till, in 1885, it took 18·63 grains of that metal to be the equivalent of one grain of gold. Silver had lost nearly twenty-one per cent of the value which it had maintained, as a rule, till 1871. At the present writing the depreciation has reached twenty-two per cent. This depreciation is regarded by MM. Laveleye, Cernuschi, and De Soubeyran, as the result of the demonetization of silver by Germany and the Latin Union; but this demonetization, only partial in Germany, was merely an incident in the matter, and inadequate to produce so great an effect. A much more important factor is the increase in the production of silver, which has been enormous during the last fifteen years, accompanied by considerable reductions in the expense of the processes for extracting it, the effect of which is also intensified by a greatly diminished production of gold. With a tripled production of silver, which the statistics show to have taken place, and a reduction of one third in the amount of gold, also proved by the statistics, we need go no further to find the explanation of the change which has taken place in the relative value of the two metals. From 1851 to

1855 the value of gold produced exceeded that of silver in the proportion of seventy-seven and a half to twenty-two and a half; in 1884 the proportions were reversed, and the value of the silver produced was to that of the gold as fifty-seven to forty-three.

The question now arises whether the relative rarity of gold has been adequate to exercise a sensible influence on prices and on the commerce of the world as a whole. Many writers insist that the two phenomena are connected, because they are simultaneous. It is also worthy of remark that the production of gold fell off at the very time when a considerable number of nations turned to that metal as the basis of their monetary circulation; when the United States and Germany resumed specie payments in gold and Italy began to hoard it. The reasonings of these persons contain some facts mingled with conjectural inductions. Times of commercial crisis are always characterized by depression of values. In making our comparisons we should be careful to set off ordinary years against ordinary years, and not let peculiarly exceptional years, such as sometimes occur, slip into one side of the comparison to exaggerate the apparent difference. The depreciation of values, moreover, which is spoken of now, is not universal; but many articles have escaped it, or have been only feebly affected by it. A considerable number have held their own, or have risen in price, during the past twenty-five years. Tin has fallen but slightly; the same is the case with soap and bottles. In alimentary products the great depreciation which is talked of is hardly visible, except in wheat, coffee, and sugar. Salt, beer, butter, and pepper have risen. Meat falls but slowly, if at all, and hides are dearer than they were between 1861 and 1870. Through the list as a whole, the tendency to depreciation, it is true, is dominant, but the exceptions are numerous and important. When we turn to human services, of whatever kind, whether professional or those of common laborers, we find that salaries and wages have risen all around. Now, if the cause of the present crisis were the increase in the value of gold, the prices of everything, without exception, would have fallen. They have not done so, and we must look for other causes. If we look without prejudice, they will not be hard to find. Two conditions may be discovered existing in combination in the cases of all articles the price of which has fallen—that the production has become remarkably more abundant and the expenses of it have notably diminished. We find both these conditions existing in wheat, cotton, coffee, iron, cast-iron, copper, and everything else that is cheaper.

The amount of territory in cultivation in wheat has increased enormously: in Europe, thirty-four per cent in less than thirty-five years; in the United States, by nearly tripling in thirty-four years and doubling in fourteen years; in the British colonies outside of India, nearly as much. Contrary to the predictions of Malthus and Ricardo, the last quarter of a century has seen food-substances, through the whole

civilized world, multiplying much more rapidly than the population. M. de Neumann-Spallert, a statistician of high reputation for accuracy, has shown that the trade of the civilized world in cereals more than doubled between 1869 and 1879. Since then it has suffered a slight recoil. The production of cotton, which was estimated at 1,192,000,000 pounds in 1840, and 2,474,000,000 pounds in 1860, remained nearly stationary—increasing only about three and a half per cent—between 1860 and 1870, on account of the American civil war; but between 1870 and 1880 the crop of the United States rose from 1,540,000,000 to 3,161,000,000 pounds, and the crop of the whole world to 4,039,000,000 pounds, showing an increase of about sixty-seven per cent in ten years. But this is insignificant by the side of the increase that has been realized in the production of wool. A commercial circular, issued by one of the principal brokers of Antwerp, has recently established in the most striking manner the relations of the price to the quantity of wool imported into Europe. Taking into consideration the stocks of colonial wools coming from the three principal producing countries, Australia, the Cape Colony, and La Plata, we shall find that in 1864 the importations amounted to only 458,000 bales; in 1868 they had nearly doubled, and reached 879,000 bales. The price then fell to one franc eighty-five centimes (about twenty-five cents), and for a short time in 1869 to eighty-five centimes (or about seventeen cents), the lowest price that had then been known. For five or six years the importations remained stationary, or only increased a little, and prices stiffened. But in 1877 the importation was much more considerable, amounting to 1,272,000 bales, or forty per cent more than five years previously, and prices fell in nearly a corresponding proportion. For the next two or three years the colonial importations were stationary, and prices rose. But the increase in production was resumed; the importation of wools into Europe was estimated at 1,740,000 bales in 1885, and prices descended correspondingly.* A considerable increase, though not so great, has taken place in the production of coffee, which has risen from 321,000 tons in 1855 to 588,000 tons in 1881, or sixteen per cent. This is not very great, but the increase in the use of coffee is still slower. The production of sugar has increased more rapidly. The increase in the production of cane-sugar in 1882 amounted to about one third in five years, and that of beet-sugar in 1883 to forty per cent in three years. Since these dates the production seems to have taken a new start.

A glance at the statistics of metal-working ought also to convince a reasonable man that the cause of the fall in prices should be sought in the conditions of the production of each article. Fine copper is one of those metals which have fallen most within fifteen years. The production of it, which was only 45,250 tons in 1850, and 67,370 tons in 1860, reached 82,120 tons in 1870, and over 120,000 tons in 1880,

* See this circular in "l'Économiste français," February 7, 1886.

and this figure was passed in the following years. The case is not different with lead, the production of which, 104,000 tons in 1830 and 170,500 tons in 1850, passed 379,000 tons in 1880, or was more than doubled in thirty years. The production of iron has doubled in ten years, and that of coal increased about 145 per cent in twenty years.

We might pursue this enumeration almost to infinity. If, however, instead of studying the special and precise cause of the depression in the price of each article, we seek the more general causes, they are easy to find. The question of the metal silver is foreign to them. The general causes may be reduced to the following: The whole world is much better explored than it was twenty years ago, and all the natural riches, the best lands, and the best deposits, are better known. Capital, having become more abundant, is more mobile and more active, bolder, more ready to change places, and more transportable than it was a quarter of a century ago, so that the simple announcement of the discovery of a new source of wealth at any place in the world almost immediately induces attempts to make it available. The rise of anonymous business societies, or companies, has an importance of which we are hardly yet beginning to take account; the substitution of this powerful collective force for the molecular forces of personal and isolated capital has transformed and sometimes decupled the efficacy of investment. Men also have become less sedentary, and eagerly follow their capital wherever it calls them and promises them remuneration. The progress of industry, manifested by inventions, discoveries, improved processes, and even workmen's slights, is contributing daily to this incessant development of production and cheapening of prices. The last factor, and not the least energetic one, is the improvement of the means of transportation, especially by sea, during the last fifteen years, by virtue of which it is calculated that every English ship can now carry twice as much freight as in 1870, three times as much as in 1860, and four times as much as in 1850.

These are the general and incontestable causes which have acted, and are continuing to act, upon the provisioning of the world. To seek the explanation of the fall of prices anywhere else is willfully to close one's eyes. It is vain to pretend that the fall of silver, which amounts to twenty-two per cent of the value given it in our monetary tariff, gives the Indies an advantage in exportation. Amid phenomena so vast and striking, this is only an insignificant detail. The greater part of the goods which have drooped in price are not produced in countries having a silver standard. The great marts of production of copper, for example, are not in the East, but in the West—in Spain and the United States. So with iron and with wool, which is peculiarly the product of countries having a gold standard. Sugar and cotton, also, are most largely produced in countries where the fall in silver can have no direct influence.

It would be well if we could come to an understanding of the real

effect of a depreciated currency upon the external commerce of a large country. It is often asserted of India that the depreciation of silver has given it a great advantage, because it can sell its goods at a price which calculated in gold would be less than that charged by competing countries; but, on the other hand, nearly all the finance officers of India and England are suffering from the embarrassments inflicted upon the Indian treasury by this very decline. If we admit the principle that a depreciated currency is an advantage to a country, we should conclude that Russia is never more prosperous than when its ruble declines, the Argentine Republic and Brazil than when their forced paper loses another fraction of its nominal value; and that those countries, like Italy and the United States, which exerted themselves to pass from the *régime* of paper money and resume specie payments, committed a false step, because, in substituting a strong and stable currency for a weak and variable one, they made exportation more difficult. It may be acknowledged that a slow and gradual depreciation of the value of money may at first aid to a certain extent in the development of exportations. But this is only a transitory phenomenon. All prices will soon come to a level, and salaries and wages will rise; and the temporary advantages accruing to producers and exporters will vanish. If the foreign commerce of India has sensibly expanded within the last fifteen years, we can point out more palpable, precise, and certain causes for the increase than the fall of silver, in the development of the network of railways, the operation of the Suez Canal, with the continual reductions in its tolls, and the cheapening of marine freights. Railroads and steamboats are the great levelers of prices. Add to these the effect of all the improved processes for loading and unloading, such as grain-elevators and all the new port facilities, and we shall find in this whole of circumstances so varied and yet so concordant a cause for the cheapening of goods much less problematical than the depreciation of silver.

There is another consideration to be taken account of when we refer the fall in prices to the diminished production of gold. It is not correct to suppose that it is indispensable for the maintenance of prices that the quantity of the precious metals which form the standard shall be increased in proportion to the extension and volume of commerce. Numerous recent discoveries contribute to permit economy in the circulation of the precious metals. Submarine telegraphs, for example, more exact knowledge of the ocean-currents, the cutting of isthmuses, and improvements in the steam-engine are diminishing the use of these metals in international commerce. If we wish to send a million dollars in bullion from America to England, it will only take six or seven days now against the twelve or fifteen days that it took twenty years ago. Specie can be sent now from Australia to Great Britain in thirty-five days, where it took ninety days a quarter of a century ago. This shortening of the time required for the trans-

mission of gold is really equivalent to an increase in the available quantity of it. Furthermore, the methods of payment by balances between one market and another have become more varied and abundant. The simple development of international credit permits us to transfer funds from one country to another without a grain of gold being moved. Bank-notes circulate among all classes of the population in all countries, and checks have become everywhere a more usual means of payment. Piled up in the great banking-houses, the precious metals suffer less diminution by wearing, by material loss, and by hoarding. The whole world is thus managing to make less and less actual use of metallic money. To all the causes of decline we have passed in review may be added another cause, accidental and temporary, but effective while it continues in operation—the check to speculation. Speculation is as necessary to commerce as Achilles was to the army of the Greeks. It is that which gives life to trade, sustains prices, and fills the heart with hope. Without it everything languishes.

The reader may now be ready to infer from this review that an excess of production is the cause of the crisis. We are producing too much, and mankind is poor because of its wealth. Men are troubled to get enough to eat, to dress themselves, and to find lodging, because we are producing too much food, making too many clothes, and building too many houses! It can hardly escape any one that this explanation, when presented in this straightforward way, has a queer look. Have we really produced too much? Can we produce too much? At any rate, can it ever happen that an excess of production will engender misery? Such an hypothesis, at least in respect to the production of articles of subsistence, can hardly be admitted. Humanity has so many wants, natural or artificial, that it will never be satisfied, and we shall always have work to do for it. The old needs are extensible, and new ones are arising every day. When the man is warmly clad and he can not put on more clothes without loading himself down, he thinks about putting carpets on his floors and pictures on his walls. Consumption has unlimited appetites. It may, however, be admitted that there can be over-production of particular articles. Some humorous fellow, for instance, has suggested that we might make too many coffins, and, be they ever so cheap, the demand for them would not increase. But even in this case, perhaps, the taste would be stimulated for finer and more expensive coffins, and manufacturers would still have something to do. So there are a few other articles of which the number or quantity capable of being made useful is limited, but the quality of which is capable of indefinite expansion. In articles of personal use, like shoes and clothing, more abundant production and cheapening are apt to have the effect of causing us to change them often and to be more careless about having them repaired, and thus open the way to a larger demand for them. There are also articles not essential, but serving as instruments of

labor of which there might be too many made. We might conceive of an excess of needles, or of looms, or spinning-wheels, or locomotives, or steamboats. But these are exceptional cases. Of most of the articles that are made for direct consumption we may say, as a rule, that they can not be offered in absolute excess. The world is never likely to have too much cloth, or sugar, or coffee, or meat, or wheat, or even too many houses. A great many people in comfortable circumstances, to say nothing of those who are poor, would have many more carpets and paintings, would use more sugar, would take coffee more frequently, would eat more meat, and enjoy more costly food, and would live in better houses, if it were not for the expense and for the habits they have already formed under the restraint of the cost of living. There can not really be an excess of any of these articles. If the supply is at any time in excess of the demand, it is not because this is not capable of increase, but because the increase is restrained for the time by circumstances which will prove to be only transitory. Take the case of houses in Paris. They say there have been too many built. Too many, it is true, for the builders to sell immediately at a profit; but not too many for the population who are all the time complaining of being lodged in too close quarters, and would gladly exchange their two rooms for three, and their three for four or five, if they could afford it.

We sometimes say of children or young people that they have grown too much. The expression is inexact, for we do not mean that we should wish to see them smaller again; but we mean that they have grown up so quickly that their bodily functions and their carriage have not had time to adapt themselves to the new and unaccustomed size. The case is very similar with what we are accustomed to call crises of over-production. Taken in a general sense, this expression too is inexact. We must not conclude from its use that men should try to go back and produce less. It is only a "growing-pain," the result of a useful phenomenon being produced too abruptly, before there has been time to modify habits, establish new agencies, and adapt society to the new conditions, which operations have to take place gradually. Time and the course of events will furnish effectual remedies for the momentary inconvenience.

We must be on our guard against the empirics and charlatans who are continually besieging the public powers of suffering nations. First among these are the protectionists. "The world," they say, "is producing too much; we have to struggle against universal competition. We have the remedy in our hands. We must proscribe foreign goods and encourage our own." This kind of reasoning has lately come into new credit. Nothing can be more unreasonable. Protectionism is, in fact, largely responsible for the present crisis. Let us judge of its effects by a few examples. Among the articles that are most largely produced and have suffered the greatest decline in price

are steamboats, railroad-iron, metals, and sugar. These very articles are the most highly protected ones in nearly every country. Too many steamers have been built, and freights have fallen below a paying price. What is there strange about that, when England has gone into the business with all the acquired advantages and prestige of her maritime supremacy, and most of the other nations are encouraging the building of ships with all their might by means of direct appropriations, differential duties, subventions, or special postal privileges? To make the disproportion still greater, protectionism is now at pains to reduce as much as possible the amount of freight which this surplus of ships will have to carry. By its discriminating duties, it tries to restrict, or even completely to prevent, the importation of foreign goods. If you will have a marine, and go to the extent of subsidizing it, you ought to have something for it to carry. Now, it can carry nothing but goods coming from abroad or going abroad. The protectionist policy of most of the countries practicing it can be reduced to the maxim, "Get by means of subsidies and prizes, as large a marine as possible, and secure for it, by protection and prohibitory duties, as little freight as possible"!

The deplorable effects of the protectionist *régime* are no less evident in general metallurgical industries. Protection is given everywhere by means of extravagant duties. In France, the duties represent from fifty to sixty per cent of the current value of the goods. Yet these industries are among those that are languishing the most. This is because the effort has been made everywhere by means of customs duties to stimulate them to excess. In the United States, Russia, Austria, Italy, Spain, and France, the people have been persuaded that they can not build enough furnaces and machine-shops; and the result has come about that Spain has by great exertions succeeded in sending a locomotive to England, the very home of steam-engine making, for sale. All countries are taxing their ingenuity to build up their export trade. Formerly this was the branch of business which returned proportionately the most profit; now it returns the least.

In no industry does the absurdity of the protectionist system make a clearer exhibition of itself than in the trade in sugar. France, Germany, Austria, Italy, Belgium, Holland, and Russia, are each laboring to make their national sugar industry the greatest in the world. Each of them gives premiums, by ingenious devices, upon exportation. The consequence of their efforts is, that this sugar industry, the object of extraordinary favors, has gone entirely astray from its natural ways. Production is pushed everywhere. The cost price is not considered, but only the export price; and the point has been reached that so much sugar is made in every country that the price is going down every day. Governments are induced by this fact to increase their favors, and then the price takes another fall.

While it has a less palpable influence in the generality of cases, the

protectionist policy is not less unfavorable to industry as a whole. If the market for most of our export products is restricted, one of the causes for it is to be found in the fact that between 1878 and 1880 France converted most of the nations to protectionism; we set them the example and they followed it. We repel foreign wheat, cattle, and cotton-thread, and they repel our *articles de Paris*, silks, furniture, and wines. The principal factor in the disproportion between the production and consumption of certain articles is the customs tariff. It acts in two ways: by depriving the export trade of the markets to which it has been accustomed, and by stimulating new manufactures which are destined in their turn to find no market. Finally, commercial treaties having no longer a real existence, because they are almost reduced practically to a clause conferring no fixed rights—the most-favored-nation clause—there results a great instability in tariffs, and consequently in international relations.

Another factor of the crisis may be found in the extravagant public works undertaken by states. The whole European Continent and some distant countries have plunged up to their ears in vast enterprises which are supposed to be of public utility. The thought that great works can not be indefinitely carried out, that their efficacy is limited, that beyond a certain point they do harm to one another, and bring no more aid, no durable stimulus to industry, simple and true as it is, has become strange to the light heads that rule parliamentary countries and democracies. A large country may derive much profit from half a dozen first-class ports; but what real advantage can come from turning the thousand creeks which indent the shores into ports? It would be about the same thing if a man, instead of having one or two outside doors to his house, should cut up his whole first floor into doors. The case is the same with roads and canals. Beyond a certain extent, they serve no other purpose than to withdraw the land they occupy from cultivation. In a country of 500,000 square miles, the first 20,000 miles of railroad are very useful; the next 5,000 miles much less so, while 5,000 miles more would be an excess, a luxury to which we might perhaps afford to apply our surplus profits, but which it would be foolish to pay for out of the capital fund. Every new mile of railway opened in France produces a small income, but three fourths of it is simply so much revenue diverted from other roads, and not the product of a new traffic. This unreasoning activity in constructing useless public works which prevails in many countries adds at once to the burdens upon industry and to its instability. It has contributed to withdraw masses of laborers from the regular cultivation of the soil, to cause abrupt rises of wages, and to make workmen more exacting and more refractory to discipline; it has given a factitious development to metallurgical industry, and it has cast disorder into budgets, hollowed out deficits, necessitated enormous imposts, and increased public debts or postponed the day when they will be paid.

Many light heads are still eager to come to the relief of suffering workmen by modifying legislation and opening mines. If these counselors would take the trouble to reflect, they would see that all intervention of the state in the economical domain is essentially disturbing. It is an element of instability, disorder, and waste. With their customs laws which they are constantly making and unmaking; with the changes with which they threaten mining property, sometimes funded property; the free exercise of industries and the freedom of contracts, with the inconsiderate public works they undertake; the loans they contract; the new places they create, and the parasitism they develop, governments, while they are no more useful than flies on a carriage-wheel, count for a great deal in the existing economical crisis. They contributed to bring it about, and they are contributing to prolong it.

For a permanent cheapening of the cost of production a third factor should be reckoned upon—improvement in workmanship. It would be puerile to ignore the fact that the workmen of Western countries, well endowed as they are in other respects, have become infatuated with the new conditions of their life. A too rapid increase of wages, superficial instruction, the sudden possession of political and civil rights which their fathers had not, concentration in cities with a corresponding withdrawal of workmen from the country, all together have contributed to exalt the conceit of a great number of workmen, and especially of their leaders. The results are a seeking for extravagant wages, habits of partial idleness, and a general looseness in the matter of days' works. It would no doubt be a most desirable consummation if the general condition of mankind were such that we could pay even unskilled laborers such wages as they are sometimes able to command in the great cities. But it is not the case. In the world at large nine tenths of the industrious classes are at a long distance from such conditions. Western workmen, especially in the United States, England, and France, forget that by reason of exceptional circumstances they constitute a kind of aristocracy of labor. Like all aristocracies, they have at last given way under their exaltations to the point of losing the taste for labor and the practice of doing their work conscientiously; and their leaders are trying to draw them still further away from the feelings and habits which enter into the make-up of the good and solid workman. Western civilization is incurring a great peril from this source. When China is fairly opened to the world and has become a country of railroads and factories, it will become necessary to make a new adjustment of wages and holidays all over the world, as has already been done with the prices of goods. The exceptional wages of the day, and the two or three "off days" a week, can not survive the approaching competition of the extreme East. The reform that it is desirable to make should not await the coming of this imminent event, or the conversion may be too late. As capitalists have been obliged to accept the situation and resign themselves to a gradual

diminution of their profits, so workmen, the unfaithful ones at least, among Western peoples, will have to recover the habits of regular and conscientious work, which were formerly in honor, but upon which they are now trying to cast discredit. Possibly, most of the additions to wages that have been made in later years will have to be reduced; but this will be compensated for by the greater regularity of work and the general cheapening of the necessaries of life.

In addition to the factors we have described, a new arrangement of commercial agencies is needed to the full bringing about of the equalization of consumption with production. In most countries the economical organism is complicated with superfluous wheels. The curiously abnormal situation is presented that, while the producer gets lower prices, the consumer pays no less. The number of middle-men also grows quite as fast as the difference between wholesale and retail prices, so that they too make no great profits. Two evils results from these conditions: many persons are lost from work on the farm or in the shop; and the consumer, not profiting or profiting but little by the cheapening of prices, does not extend his consumption. No equilibrium can be established between a production that is increasing and a consumption that remains nearly stationary. The state has no part in this situation; but producers and consumers sin by indifference to one another; and the remedy for the result should be brought about by their joint action in creating market depots at which they can be brought into more direct relations. The state may best facilitate such arrangements by leaving the parties at perfect liberty. Its interference in any way would be a blunder, and only a hindrance to the accomplishment of the desired end.

The present crisis has a much more general character than any of the crises that have preceded it, because it is a part of an abrupt transformation in the production and circulation of the whole world. For the same reason it is destined to last longer. Nevertheless, if governments have wisdom and foresight enough not to interfere with the course of events, an era of improvement may shortly begin. Those persons who occupy their minds with plans to induce interference by the state in the interest of labor and enterprise, whether by the purchase or establishment of works, stimulation by bounties, discriminating taxes, or by rules for the regulation of the relations between workmen and their employers, show more zeal than wisdom, and are asking what will only aggravate the evil. The action of the state in such matters is essentially disturbing, and can never be regulative. All that we should ask of it is not to interfere, but to retrench its own expenses, to contribute by economical administration to the reduction of costs of production, and by a calm and wise attitude to the revival of confidence.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE PHYSICAL LABORATORY IN MODERN EDUCATION.*

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FROM the moment we are born into this world down to the day when we leave it, we are called upon every moment to exercise our judgment with respect to matters pertaining to our welfare. While Nature has supplied us with instincts which take the place of reason in our infancy, and which form the basis of action in very many persons through life, yet, more and more as the world progresses and as we depart from the age of childhood, we are forced to discriminate between right and wrong, between truth and falsehood. No longer can we shelter ourselves behind those in authority over us, but we must come to the front and each one decide for himself what to believe and how to act in the daily routine and the emergencies of life. This is not given to us as a duty which we can neglect, if we please, but it is that which every man or woman, consciously or unconsciously, must go through with.

Most persons cut this gordian knot, which they can not untangle, by accepting the opinions which have been taught them and which appear correct to their particular circle of friends and associates; others take the opposite extreme, and, with intellectual arrogance, seek to build up their opinions and beliefs from the very foundation, individually and alone, without help from others. Intermediate between these two extremes comes the man with full respect for the opinions of those around him, and yet with such discrimination that he sees a chance of error in all, and most of all in himself. He has a longing for the truth and is willing to test himself, to test others and to test nature until he finds it. He has the courage of his opinions when thus carefully formed, and is then, but not till then, willing to stand before the world and proclaim what he considers the truth. Like Galileo and Copernicus, he inaugurates a new era in science, or like Luther, in the religious belief of mankind. He neither shrinks within himself at the thought of having an opinion of his own, nor yet believes it to be the only one worth considering in the world; he is neither crushed with intellectual humility, nor yet exalted with intellectual pride; he sees that the problems of nature and society can be solved, and yet he knows that this can only come about by the combined intellect of the world acting through ages of time, and that he, though his intellect were that of Newton, can, at best, do very little toward it. Knowing this, he seeks all the aids in his power to ascer-

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tain the truth, and if he, through either ambition or love of truth, wishes to impress his opinions on the world, he first takes care to have them correct. Above all, he is willing to abstain from having opinions on subjects of which he knows nothing.

It is the province of modern education to form such a mind, while at the same time giving to it enough knowledge to have a broad outlook over the world of science, art, and letters. Time will not permit me to discuss the subject of education in general, and, indeed, I would be transgressing the principles above laid down if I should attempt it. I shall only call attention at this present time to the place of the laboratory in modern education. I have often had a great desire to know the state of mind of the more eminent of mankind before modern science changed the world to its present condition and exercised its influence on all departments of knowledge and speculation. But I have failed to picture to myself clearly such a mind, while, at the same time, the study of human nature, as it exists at present, shows me much that I suppose to be in common with it. As far as I can see, the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with and of whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where everything has a personal aspect and we are guided by feelings rather than reason.

When, by education, we attempt to correct these faults, it is necessary that we have some standard of absolute truth ; that we bring the mind in direct contact with it, and let it be convinced of its errors again and again. We may state, like the philosophers who lived before Galileo, that large bodies fall faster than small ones, but when we see them strike the ground together we know that our previous opinion was false, and we learn that even the intellect of an Aristotle may be mistaken. Thus we are taught care in the formation of our opinions, and find that the unguided human mind goes astray almost without fail. We must correct it constantly and convince it of error over and over again until it discovers the proper method of reasoning, which will surely accord with the truth in whatever conclusions it may reach. There is, however, danger in this process that the mind may become over-cautious, and thus present a weakness when brought in contact with an unscrupulous person who cares little for truth and a great deal for effect. But if we believe in the maxim that truth will prevail, and consider it the duty of all educated men to aid its progress, the kind of mind which I describe is the proper one to foster by education. Let the student be brought face to face with Nature ; let him exercise his reason with respect to the simplest physical phenomenon, and then,

in the laboratory, put his opinions to the test; the result is invariably humility, for he finds that Nature has laws which must be discovered by labor and toil, and not by wild flights of the imagination and scintillations of so-called genius.

Those who have studied the present state of education in the schools and colleges tell us that most subjects, including the sciences, are taught as an exercise to the memory. I myself have witnessed the melancholy sight, in a fashionable school for young ladies, of those who were born to be intellectual beings reciting page after page from memory, without any effort being made to discover whether they understood the subject or not. There are even many schools, so called, where the subject of physics or natural philosophy itself is taught, without even a class experiment to illustrate the subject and connect the words with ideas. Words, mere words are taught, and a state of mind far different from that above described is produced. If one were required to find a system of education which would the most surely and certainly disgust the student with any subject, I can conceive of none which would do this more quickly than this method, where he is forced to learn what he does not understand. It is said of the great Faraday that he never could understand any scientific experiment thoroughly until he had not only seen it performed by others, but had performed it himself. Shall we, then, expect children and youth to do what Faraday could not do? A thousand times better never teach the subject at all.

Tastes differ, but we may safely say that every subject of study which is thoroughly understood is a pleasure to the student. The healthy mind as well as the healthy body craves exercise, and the school-room or the lecture-room should be a source of positive enjoyment to those who enter it. Above all, the study of nature, from the magnificent universe, across which light itself at the rate of 186,000 miles per second can not go in less than hundreds of years, down to the atom of which millions are required to build up the smallest microscopic object, should be the most interesting subject brought to the notice of the student.

Some are born blind to the beauties of the world around them, some have their tastes better developed in other directions, and some have minds incapable of ever understanding the simplest natural phenomenon; but there is also a large class of students who have at least ordinary powers and ordinary tastes for scientific pursuits; to train the powers of observation and classification let them study natural history, not only from books, but from prepared specimens or directly from Nature; to give care in experiment, and convince them that Nature forgives no error, let them enter the chemical laboratory; to train them in exact and logical powers of reasoning, let them study mathematics; but to combine all this training in one, and to exhibit to their minds the most perfect and systematic method of discovering the ex-

act laws of Nature, let them study physics and astronomy, where observation, common sense, and mathematics go hand in hand. The object of education is not only to produce a man who *knows*, but one who *does;* who makes his mark in the struggle of life, and succeeds well in whatever he undertakes; who can solve the problems of Nature and of humanity as they arise, and who, when he knows he is right, can boldly convince the world of the fact. Men of action are needed as well as men of thought.

There is no doubt in my mind that this is the point in which much of our modern education fails. Why is it? I answer that the memory alone is trained, and the reason and judgment are used merely to refer matters to some authority who is considered final; and, worse than all, they are not trained to apply their knowledge constantly. To produce men of action they must be trained in action. If the languages be studied, they must be made to translate from one language to the other until they have perfect facility in the process. If mathematics be studied, they must work problems, more problems, and problems again, until they have the use of what they know. If they study the sciences, they must enter the laboratory and stand face to face with Nature; they must learn to test their knowledge constantly and thus see for themselves the sad results of vague speculation; they must learn by direct experiment that there is such a thing in the world as truth, and that their own mind is most liable to error. They must try experiment after experiment, and work problem after problem, until they become men of action and not of theory.

This, then, is the use of the laboratory in general education, to train the mind in right modes of thought by constantly bringing it in contact with absolute truth, and to give it a pleasant and profitable method of exercise which will call all its powers of reason and imagination into play. Its use in the special training of scientists needs no remark, for it is well known that it is absolutely essential. The only question is whether the education of specialists in science is worth undertaking at all, and of these I have only to consider natural philosophers or physicists. I might point to the world around me, to the steam-engine, to labor-saving machinery, to the telegraph, to all those inventions which make the present age the "Age of Electricity," and let that be my answer. Nobody could gainsay that the answer would be complete, for all are benefited by these applications of science, and he would be considered absurd who did not recognize their value. These follow in the train of physics, but they are not physics; the cultivation of physics brings them and always will bring them, for the selfishness of mankind can always be relied upon to turn all things to profit. But in the education pertaining to a university we look for other results. The special physicist trained there must be taught to cultivate his science for its own sake. He must go forth into the world with enthusiasm for it, and try to draw others into an appreciation of it, doing his part to

convince the world that the study of Nature is one of the most noble of pursuits; that there are other things worthy of the attention of mankind besides the pursuit of wealth. He must push forward and do what he can, according to his ability, to further the progress of his science.

Thus does the university, from its physical laboratory, send forth into the world the trained physicist to advance his science and to carry to other colleges and technical schools his enthusiasm and knowledge. Thus the whole country is educated in the subject, and others are taught to devote their lives to its pursuit, while some make the applications to the ordinary pursuits of life that are appreciated by all.

But, for myself, I value in a scientific mind most of all that love of truth, that care in its pursuit, and that humility of mind which make the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument to human reason. This is the mind which is destined to govern the world in the future, and to solve problems pertaining to politics and humanity as well as to inanimate nature.

It is the only mind which appreciates the imperfections of the human reason, and is thus careful to guard against them. It is the only mind that values the truth as it should be valued, and ignores all personal feeling in its pursuit. And this is the mind the physical laboratory is built to cultivate.

MINERAL SPRINGS OF EASTERN FRANCE.

By TITUS MUNSON COAN, M. D.

THE *terræ incognitæ* are not always the most distant lands. The greater part of France, outside of Paris, is an unknown country to the greater number even of traveled Americans; and of the little-known features of that pleasant land its abundant mineral springs are among the least known. No country in Europe is so rich in mineral springs: six hundred and fifty are enumerated in a single treatise (Le Pileur's), and designated as "among the best-known springs"; while the number of different establishments, probably about two hundred, is greater than that of any other country.

Ask, now, the first neighbor you meet, this question, which I have sometimes asked, "What French mineral springs do you know by name?" Unless he is an old traveler in Europe, and sometimes even if he be an old traveler, you will not get a very long answer—"Vichy, of course; and—and—yes, Aix-les-Bains." "And any others?" you continue. The usual answer will be either "No," or "Plombières."

Of course, persons who have traveled for the sake of their health will know the springs of the Pyrenees and of Auvergne, and will have heard of those of Central France and of the Vosges. A brief description of the leading springs in this latter group may have a practical interest for some of my readers; and at least the interest of curiosity for those to whom these healing waters are but the shadow of a name.

1. PLOMBIÈRES.—These springs are of very ancient fame, though they have become popular only of recent years. They have been known and used since the Roman time, and in the masonry around the deepest spring you are shown mason-work which dates back to the earliest Christian centuries. In 1859 a bronze water-cock and its key, of the Roman time, were unearthed in fairly good order; on turning the key, the water rushed out in a full stream. The masonry of the sub-works is probably older than this; and it is probable that bathers were disporting themselves in these vapor-chambers, now far below the level of the ground, at least two thousand years ago.

A reminder of the ancient liberty of the latter survived, until very recently, at Plombières, in the custom of men and women bathing together; this was practiced so lately as 1881, of course under suitable restrictions as to decorum. A sufficient marble partition in the baths separated the men from the women, and strict regulations as to bathing-dresses were in force. But the bathers were numerous, and the baths were greatly crowded. In one of the bathing-rooms I was shown four marble bathing-tanks—*piscines* they call them—each a circle of about ten feet in diameter, with a dozen single bath-tubs standing near by; and in these rather narrow receptacles no less than a hundred men and women sometimes bathed at a time. Naturally, they complained of the situation. Rules and bathing-dresses are very well, but such propinquity has its inconveniences in spite of rules and bathing-dresses; and it was finally found desirable to allot separate hours for bathing to the two "sects" (in Georgia phrase) of bathers. The only other place in Eastern France where men and women bathe together is at Vittel; but at these charming baths, which we shall study a little later, the crowd is not too great, and people can discuss evolution, or the dual nature of the soul, across the marble fender which separates the tanks, with the most perfect *sang-froid*, especially in the cooler baths. The absolute leisure and unoccupation of the bath, the unconventionality of the costumes, and the interest felt in meeting strangers under such peculiar circumstances, all invite to the consolations of talk; and many a pleasant acquaintance has had its beginning in the tanks of Plombières or Vittel, which lend themselves, as the phrase is, most genially to the humaner sympathies. It is no small consolation to some invalids to compare notes respecting their progress; and it must be remembered that the majority of those who frequent the baths at Plombières are actual invalids. As to any improprieties under the old system of bathing together, I can not testify: the worst that I

heard of was that there was a good deal of water-splashing by the friskier convalescents.

But let us approach the splendid establishment which lies nearest the railroad-station, the *Bain Impérial*, or *Thermes Napoléon* of the Second Empire. The latter inscription is still traceable, though very faintly, under the briefer legend of to-day, "Thermes." Confucius demands somewhere, "How can a man be concealed?" and in France one must often ask himself the same of the names in the changing inscriptions on public buildings. They usually discover, if you scrutinize them a little closely, some trace of the previous occupancy—sometimes a pathetic trace. One may not sympathize with the doings of the Second Empire, and yet it rouses a lively feeling of unfair play to see this fine establishment, like many other public works which Napoleon III executed in France, stripped even of the name of the ruler who at least did much for the material prosperity and comfort of his country, as roads and public buildings throughout France testify. An author's name goes upon the title-page of his book; surely it is not less fair that the builder's name should remain upon his edifices.

The *Thermes Napoléon*, then, are the newest, finest, and most extensive of the six establishments of Plombières, and they are among the finest in France or in Europe. The *Bain Romain*, an old establishment, rebuilt in 1837; the *Bain des Dames;* the *Bain tempéré*, in which, as I have said, the bathers were formerly so crowded; and the *Bain des Capucins*, in an old church—these all lie farther up the beautiful narrow valley in which Plombières is built; and all are much frequented, the latter especially for the cure of sterility. In all these different springs the waters are warm, ranging from about 43° to 55° C. (110° to 131° Fahr.), and in the subterranean vapor-room, where the spring bursts from the rock, the temperature runs up to 153° Fahr.—quite as high as one can well face heat in the shape of vapor. It seems to burn when it first strikes your face, but a pleasant perspiration follows. This temperature, however, that of the hot spring itself, as it has been flowing for thousands of years past from the primitive rock, is not that which is used for treatment. In the steam-room the vapor-baths are given at 113° Fahr. Nearly every variety of bath known is administered in one or another of these thoroughly equipped establishments.

The waters of Plombières are of the mildest; they are classed by some as indifferent thermal waters, but they contain silicic acid and sulphate of soda. Taken as a drink, they are stimulating to the circulation and to the nerves; they are diuretic and aperient, and sometimes produce gastric disturbance and the so-called "thermal fever" at the outset of the treatment. There is, besides, an iron spring, which is cold, and which has a similar laxative effect, unusual among chalybeate waters. The baths of Plombières, at first stimulating, have

afterward a sedative effect. A bath of an hour and a half will slow the circulation, and depress the muscular forces; but the baths are not now prescribed of such length as formerly.

And their virtues? They are employed with success in the following classes of ailments:

(*a.*) Flatulent and acid dyspepsias, with atony of the digestive system.

(*b.*) Rheumatism and gout.

(*c.*) Female complaints, especially neuralgia and engorgement of the uterus.

(*d.*) Chronic neuralgias of various kinds. Dr. Liétard, the courteous inspector, and Drs. Leclère, Bottentuit, and Daviller, are among the most prominent consulting physicians of the place.

I should add that the environs of Plombières are very attractive. The village has about eighteen hundred inhabitants; it stands where the railroad ceases to climb the valley of the Augronne, and its two or three pretty streets hang along the sides of the valley like terraces, here and there connected by steep stairways built in the hill-side and leading from one level to another.

There are pretty excursions, as everywhere in this part of France. The *Ferme Jacquot*, the *Fontaine Stanislas*, the valley of the Semouze, the Val d'Ajol, Hérival and its ruins, Saint-Etienne, a curious town of the seventh century, and the picturesque city of Remiremont, mountain-girdled, with the ruins of the ancient abbey—these are among the places to see. For a longer excursion, one should spend two days in visiting Gérardmer and the mountain-lake, high among the Vosges. But I need not specify any more pretty places in a country which is so beautiful as the east of France.

2. Luxeuil, in the Haute-Saône.—This is a pleasant little town, about three thousand years old, near the new Alsatian boundary of France, an afternoon's drive from Plombières. In spite of thirty centuries' growth, it has not as yet touched the round number of four thousand inhabitants, though during the season, from the 15th of May to the end of September, the place is flooded with guests. Luxeuil lies in a rolling country—not a mountainous one, but at an elevation (1,325 feet above sea-level) that gives cool, sometimes chilly, summer nights. The climate, however, is not a variable one, and one sleeps soundly at night at Luxeuil.

Judged by an American standard, its temperatures are equable, and their uniformity is increased by the protection which Luxeuil finds in a range of hills upon the north, covered with ancient forests—the *haute futaie* of the French classification. There, as elsewhere in France, the forestry department takes account of each tree in the forests, and they are classified according to their ages with systematic accuracy. The ages that divide the classes are forty, sixty, one hundred and twenty, two hundred, and lastly over two hundred years; and for

each class there is a descriptive name. The French forests are the best cared for in the world, and, whenever we are ready to cultivate and preserve our own, we shall have the advantage of French experience in this important matter.

The springs are fifteen in number, bearing names that come down, in some instances, from the Roman era. The *Bains des Benedictins, des Capucins, des Dames, des Fleurs*, are among the most used, flowing as they do under the roof of a single establishment with four others, the *Bain gradué*, the *Grand Bain*, the *Bain des Cuvettes*, and the *Bain ferrugineux*.

The establishment itself is a fine, old-fashioned building, very spaciously and solidly built, more than a hundred years ago, in the gray stone of the country, and much enlarged in the year 1853. It stands in the middle of a park, shut in on either hand by rows of magnificent oak and plane trees. The establishment lies like an island in the inland sea of hills and meadows which make up this region in the department of the Haute-Saône. They are the last northward-rolling undulations of the Jura.

I will not enumerate the *douches*, the *piscines*, the shower and plunge baths, nor the score of appliances which go to make up the installation or *plant* of this fine establishment. These appliances are, indeed, much the same in all the great European watering-places, and their elaborate complexity is a thing that interests one upon the spot, rather than in the description of it. Taking all this balneological battery, then, for granted, let me come to the description of the waters themselves and of their virtues.

They are thermal, ranging from 28° to 51·5° C. (82° to 125° Fahr.). They are abundant in quantity, and in quality they are of two classes: they are either predominantly saline or predominantly iron-manganese. Chemically speaking, they are mild waters; they are none the less very effective therapeutically. Some of the mildest mineral waters, both at home and abroad, are the most valuable.

And for what classes of complaints are the springs of Luxeuil especially indicated? There is no obscurity about the answer; and it will be an encouraging one to many sufferers.

The waters of Luxeuil are especially adapted to anæmia and to the complaints that arise from it; and especially to the nervous, as distinguished from the scrofulous, forms of anæmia. Need I say more to indicate the point I am coming at? The tired housekeeper who is breaking down from work and worry, the jaded society-woman whose rounds of fatiguing pleasures have impaired her nerves and her temper—nearly all, indeed, who represent our domestic types of worry, exhaustion, and nervous debility, especially in women, or who suffer from the still graver derangements of special functions which these involve—these are the preappointed visitors to Luxeuil. For such sufferers its waters are, I will not say exactly a fountain of youth, for our

belief is not easy in such waters; but a certain fountain of strength when rightly chosen and rightly used. The *clientèle* of Luxeuil is mostly composed of women and of young girls who are suffering from one, or more than one, of the protean forms of anæmia. I speak from my own observation when I say that relief is certain in cases of this nature, and that cure is frequent.

But the caution can not be too often repeated that cure or even relief, at Luxeuil, or at any other mineral spring, can only be expected when the right patient goes to the right spring. I would not send a scrofulous patient, for instance, to Luxeuil; Salins is the place for him, and for the cure of the particular form of anæmia from which he suffers. Even among the cases of nervous anæmia, with the resulting train of special symptoms to which I have alluded, there are some that should seek more strongly tonic waters than those of Luxeuil. If the patient will have himself rightly directed, by competent medical advice, to the springs that he requires, and if then he will go to these and no other, and there take the local treatment that he requires from the local physician—as at Luxeuil, from the highly accomplished Dr. Champouillon, or from either of his resident colleagues, Drs. Gauthier, Bertrand, or Paris—he will not regret the passing of three weeks in this health-giving place. I should add that the society is mostly French; and that the guest has to choose between furnished apartments, which are very comfortable and moderate in price, and the various hotels of the place. I found the Hôtel des Thermes comfortable, clean, and rejoicing in a pretty court-yard, where the birds sang all the morning; and it is a pleasure to record, though in a language that she does not know, and in words which she will probably never see, the courtesy with which the hostess of that hotel welcomed the present writer during his sojourn, last August, in the pleasant town of Luxeuil.

3. Bussang, a little to the east of Luxeuil, is the last French station toward the new Alsatian frontier. It is a quiet place, in the heart of beautiful mountains, which tower on every side; in the green valley below the establishment the Moselle slips quietly seaward from its sources in the Col de Bussang, near at hand. The mountain itself is pierced by a long tunnel, emerging from the eastward end of which you come suddenly upon the reft provinces, and see the uniform of the German forest-guards upon the highway.

The hotel stands alone upon a beautiful hill-side, a mile away from the ancient village; it is at an elevation of 2,188 feet above sea-level, in the very heart of the mountains; and, from every window of the large, quiet, clean, new building, the views are exquisite. The hill-slope that sweeps far upward behind it is a mountain-pasture or Alp, where shepherd-boys tend the cattle throughout the cool summer nights. There is a Swiss air about the place: the scenery, if less grand than that of the French and Swiss Jura, is very beautiful; and

Bussang is the headquarters for mountain excursions in the Vosges. The Ballons d'Alsace and Servance, with their wonderful views of the Swiss Alps, are but a few miles away, and Gérardmer, with its mountain-lake, is a day's excursion. I mention these local attractions, for at every mineral spring where such charms of mountain scenery exist, they form potent influences among those that are enlisted for the patient's cure. One can not find a more quietly delightful spot than Bussang.

These waters have been known and used for centuries. They are delicious to the taste, sparkling, cold, and strongly tonic, containing the bicarbonate of iron, manganese, and some arsenic. As in the excellent artificial Hygeia waters, the strong charge of contained carbonic-acid gas acts most beneficially as a digestive stimulant. They are used only internally as yet, though a bathing establishment is now in construction, which the courteous manager of the springs, M. Zimmermann, told me would be ready for use in the summer of 1886.

The waters are used for the following therapeutic purposes:

(*a.*) They are especially helpful to the digestion. In consequence they cure the anæmia of mal-nutrition, and some forms of obstinate chronic diarrhœa. In one case of the latter category which came under my knowledge while in Bussang, a cure was wrought after years of suffering and prostration.

(*b.*) The waters of Bussang are an efficient tonic for delicate invalids, and especially for persons of the lymphatic constitution. They are exported; but they throw down a part of their iron after being kept for a time.

4. VITTEL, in the Vosges.—Coming out of the mountains to the rolling country at the foot of the Vosges, and entering the valley of the Vair, we find a very interesting and completely appointed establishment, mostly of recent date, at Vittel. The springs flow in the middle of a fine park, at an elevation of 1,102 feet above sea-level. They have been known but about twenty-five years, but they attract a multitude of guests. The town has 1,343 inhabitants; the air is pure, and there is a mild mountain climate. The establishment is under the direction of the brothers Bouloumié, of whom one, the accomplished superintending physician, speaks English well. There are a casino and a theatre, as well as every device in the way of bathing and of douches; and the place is lively, cheerful, and in every way attractive—a pleasant place of sojourn.

The waters are cold, and are either predominantly iron or calcic; they belong by their constitution to a group of neighboring springs, of which Contrexéville and Martigny are the other members. They are very abundant and limpid, with but little taste; they throw down a red deposit upon the marble tanks and basins. In composition these waters are of the type of the Carlsbad waters; but they are milder in

their action. They do not purge by indigestion, as those of Contrexéville are believed to do.

Their use is in curing—

(*a.*) Gravel, when caused by uric acid.

(*b.*) Chronic ailments of the liver and hepatic colic.

(*c.*) The gout of the anæmic.

(*d.*) Vesical catarrh.

(*e.*) Enlargement of the prostate gland.

It may be added that many cases of anæmia and chlorosis find their cure at these excellent springs.

5. CONTREXÉVILLE, IN THE VOSGES.—This is another little town in the valley of the Vair, a pleasant drive from Vittel, among rolling fields of wheat. The valley is small and narrow, cutting off the breeze in summer, so that the place is hot, according to French standards, though its temperatures never approach the fervors of our own summers. Less than a thousand people are included in the census of the place; but the summer visitors count by thousands, and among them you will find now and then an American; though the great majority of the visitors here, as at all other French spas, except perhaps Vichy, are French. The park and gardens offer a lively spectacle during the season; they are planted with fine old trees, and the usual good band of music may be heard. The establishment is built upon a peninsula formed by a loop of the stream; there are parlors for reading, for conversation, for games, and a fine casino. Contrexéville has not at all an ascetic reputation, and one of the attractions claimed for the place is that you get a better dinner here than even in Paris. Situated as it is in the midst of a fertile country, rich in almost every edible product of France, there is good ground for the claim of a superior *cuisine*—one, by-the-way, that is made for the city of Bordeaux, where they claim to give the best and the best-cooked breakfasts in Europe. Certainly, the breakfast of the Bordeaux restaurants would be hard to beat in any of the various quarters of the world.

The waters of Contrexéville are cold, limpid, colorless, with a slightly ferruginous taste and smell. On standing in contact with the air they form upon their surface the filmiest film of an iris-colored pellicle that one can imagine, and the water stains the cups and glasses in which it is used. There are four springs, all belonging to the class of calcic waters. Their action is diuretic, producing a strong effect upon the kidneys; and after the fourth day there is generally a laxative effect, which continues throughout the time of treatment. The secretory functions of the skin are sometimes increased—effects which are attributed to the indigestion of the mineral water. However this may be, some of those who take the treatment are purged by seven or eight glasses of the waters, while others bear twenty or thirty easily. The waters are cold.

Their special curative values are—

(*a.*) For uric-acid gravel.

(*b.*) For vesical catarrh.

(*c.*) For enlargements of the prostate gland.

(*d.*) For gout, especially when it is hereditary, but occurs in a subject not individually predisposed by his way of life to the disease.

In all these categories of chronic disease the waters of Contrexéville, when supplemented by the kindly care of Dr. Brongniard, Dr. Thiery, or some other of the excellent physicians to be found at this station, will usually bring either cure or material relief.

6. MARTIGNY is a quiet place in a rolling plain of the Vosges, 1,272 feet above sea-level. The train voyages through this placid upland country almost like a steamer upon the long swell of the Pacific Ocean. You get off at a little station in the midst of the wheat and scarlet poppies that are blowing together in the summer wind, and enjoy the brilliant color which gives such a charm to the French wheat-growing districts during the summer; taking the stage, you are set down in front of a fine new establishment—brand-new, indeed, and scarcely yet completed—where groups of well-dressed people are gathered in the newly planted park, waiting for the dinner-hour to strike. The dining-room, by-the-way, is hardly large enough for the company. A larger dining-hall was in process of building when I was there last summer, and also a promenade for exercise during rainy weather. An excellent reading-room is a feature of the establishment.

The waters are calcic, and are substantially the same as those of Vittel and Contrexéville, but purge less than the latter. There are two springs, both cold, besides a "saponaceous" spring, so called from the unctuous feel or *texture* of the water, and from its milky appearance; of this, however, little use is made. Dr. Bridou, the physician in charge, is a serious and competent physician, a young man, but well versed in the complex subject of mineral waters in general, and of those of Martigny-les-Bains in particular. He makes no extravagant claims for their virtues. "Gout and gravel—*c'est tout*," he said to me with decisive frankness; "but surely it is much to cure these two grave complaints." Gravel in its most frequent form, that which depends upon the uric-acid diathesis, and gravel in many of the severer cases even, are relieved or cured by these most efficient waters. Regimen is carefully attended to, as at all of the best French spas; and while I will not say that regimen is exceptionally necessary in the treatment of gout and gravel, it is a part of the treatment that can not be dispensed with safely in any disease that depends upon mal-nutrition. The mistake of many patients is that when once they are arrived at a spring they think that the waters will do all. The contrary is especially true of chronic diseases, and chronic diseases are almost the only ones that are treated at mineral springs. For in chronic diseases a cure is not wrought by a succession of powerful remedial impacts, as in acute diseases it is often wrought. In chronic

diseases the cure depends rather upon a *consensus* of gentle influences, a sequence of impressions that, however slight, are wisely chosen and directed by the physician. And of these gentle influences those which come from the proper choice of diet and the right use of exercise are among the most important.

7. BAINS, still in the Vosges, is a town of three thousand people, situated at the foot of the eastward slope of the mountains, and in a valley which is watered by a tributary of the Saône. There are eleven different springs, all warm, varying from 34·3 C. to 49° C. (94° to 120° Fahr.). Their main mineral constituent is the sulphate of soda; carbonate of soda and the chloride of sodium are also present, and both arsenic and iron have been found in very small quantities. These waters are limpid, colorless, and have no smell or taste, emerging from the *grès vosgien* which covers in shallow strata the granite substructure of the valley. They have been known and used, like many others of the French springs, since the time of the Romans, and their yield is abundant, alike for the baths, douches, steamings, inhalations, and internal uses which are prescribed at the establishments.

These establishments, two in number, include all of the principal springs. The first, the *Bain Romain*, which occupies the center of the town, is a handsome building, with galleries and colonnades, dressing-rooms, douches, and three *piscines* or bathing-tanks in the center. In the basement are huge tanks where the water is stored; hence it is lifted by pumps to reservoirs in the top of the building, and distributed to all of its different parts. The second establishment, the *Bain des Promenades*, is almost equally well appointed. Some two thousand guests come yearly to the place between the middle of May and the middle of September, the limits of the season; while the course of individual treatment is commonly fixed at twenty days.

These waters have a greatly stimulating effect, which is beneficial in cases of feebleness or of nervous dyscrasia; used as baths, they are more or less stimulating according to their temperature; after a certain time they produce a sedative effect, in this particular resembling the springs of Plombières, which are but ten miles distant. Taken inwardly, they produce at first more or less of the so-called "thermal fever," i. e., loss of appetite, a sense of weight at the stomach, and some constipation, and, like the waters of Plombières, they are very useful in dyspepsia, when this depends upon feebleness of the nervous system; in gout and rheumatism, and neuralgia and engorgement of the uterus. The choice between the two springs is between hill and plain, between the more fashionable and the quieter place. In either the patient will find a cure if he follows the course of hygiene and of water prescribed.

8. BOURBONNE, in the Haute-Marne, is the last in the group of springs which we are studying. The town lies some fifteen miles due south of Martigny, whence I made my way by private carriage; and

through what a region of pastoral calm, of smiling prairie and waving grain! Never have I seen such repose and beauty combined with the highest cultivation; one would call this part of France a garden of Eden, but for the fact that it is grain, not fruit, which is here mainly cultivated, and an apple-orchard is the proper connotation of the garden of Eden. On the southward limit of this lovely rolling upland, not yet invaded by the railway, a long ridge of eastward-trending hills arises; at its foot are the springs, the pretty town of four thousand people, at eight hundred and ninety-two feet above sea-level, and the railroad. On the hill-side are enormous distributing tanks, into which the steaming-hot mineral waters, too hot for use, are pumped up daily to cool under the starlight until they are at a usable temperature for the baths of the following day.

These waters, again, have been known and used since the Roman time, but especially since the sixteenth century. There are six principal springs, ranging from 28° to 66° C. (82° to 151° Fahr.); the water is limpid, with a slightly saltish taste, and one of the springs, the *Source de la Reine*, disengages a gas which has an odor distinctly the converse of attar of roses. These waters contain the chlorides of sodium and of magnesium, with sulphate of soda and a little iron; and they are used in all the ways known to modern balneology, the new establishment being completely provided with every form of apparatus —*douches*, *piscines*, vapor-baths, *baignoires*, and the new treatment by spraying with the "pulverized" or minutely divided water—a treatment now beginning to come into use at some of the springs in our own country.

Rheumatism, the scrofulous diathesis, and old wounds, are the ailments mainly treated here; and so efficacious are these waters in the latter class of cases, that the French Government sends many of its wounded officers and soldiers here. Dr. Magnin, the old inspector, and his genial nephew of the same name, and Drs. Cabrol, Bougard, and Causard, are among the excellent physicians of the place. Among the hotels, no more comfortable and quiet place can be found than the Maison Beaurain. M. Beaurain, the most affable of hosts, speaks English as well as French, and has a most refined class of guests.

Bourbonne-les-Bains is a pleasant place, and its waters are valuable and effective. But in deciding upon treatment it is not enough to know that the waters are good and that the place is pleasant. The waters must be adapted to the particular case. The main secret of successful treatment by mineral waters is in their right choice, and as to this I have one word of serious advice. *Don't try to choose for yourself.* The right prescription and choice among these delicate yet potent remedies can only be made by a physician who understands them, who has seen and studied their action, and who also understands the case for which treatment is required.

GOOD TIME AND ITS ASCERTAINMENT.

By Professor ISAAC SHARPLESS.

THE natural divisions of time are the year and the day. The week is arbitrary, being probably derived from considerations first suggested by the first chapter of Genesis. The month, though originally intended to be the time from one new moon to the next, has, of necessity, departed from this idea, in order to make an even number in the year. The decade and the century are purely artificial, deduced from our system of numbering. But the day and the year, the one derived from the reappearance of light and darkness, the other measuring the round of the seasons, are universally adopted units of time, suggesting themselves alike to cultured and savage, and which we can not think will ever be superseded.

The year is the time of the revolution of the earth around the sun. Its measure is most easily obtained by the reappearance of the sun at the same altitude in the sky. Every one knows that it is higher in summer than in winter. If the circle of the earth's equator were extended right out from the center of the earth into the sky, it would cut out a circle there which is called the celestial equator. Now, the sun crosses this line in the spring northward, arriving at its greatest altitude in the middle of summer; thence it descends, crossing the line southward in the fall, and reaching its lowest point in midwinter. The ancients, by measuring the length of the shadow cast by a vertical stick on different days of the year, arrived at surprisingly correct results as to the length of the year. In 450 B. C., Democritus asserted the year to be 365¼ days long, which is within about eleven minutes of the truth. Another ingenious device for the same purpose was that of the Egyptian astronomers, who set up a wheel parallel to the plane of the equator. When the sun was in this plane, the shadow of the sunward side of the wheel would be exactly intercepted by the other, and the interval between two such occurrences would measure the year. Owing to the fact that the sun does not cross the celestial equator in the same place each year, this year which measures the seasons is a few minutes shorter than the exact time of the earth's motion around the sun.

To measure the day troubled the ancients much more. It is, perhaps, a common idea that the shadow of a vertical rod cast by the sun is always exactly northward at twelve o'clock noon. Any one desirous of trying this can easily do so, and he will find that such a shadow would be sometimes eastward and sometimes westward of the meridian-mark at noon. Moreover, he will find that the time between two passages of the sun over his meridian is not the same, so that, if this time were taken as the day, there would be no uniformity. It was,

however, the recognized day in most countries till comparatively recent times. In France, when in 1816 the change was made to our present system, there were fears of a disturbance among working-people, lest the abolition of the sun-day should somehow increase their hours of labor. It met the approval of the watch-makers, however, whose customers had hitherto complained that their watches would not keep pace with the sun, not knowing that this would be impossible for a good watch.

The time of the rotation of the earth on its axis can not be measured directly from the sun, for the reason that the earth is moving around it. We must have some external point, fixed with reference to the earth, by which to measure it. The stars afford such points. By noticing the time between two successive passages of a star over our meridian (our meridian being, as is well known, the semicircle in the sky passing from the north to the south point of the horizon directly overhead), we would obtain the exact time of the earth's completing one spin on its axis. This time, which is about four minutes less than our ordinary day, is called in astronomical parlance a sidereal day, and, divided in the ordinary manner into hours, minutes, and seconds, is known as sidereal time. It has no direct relations to ordinary life.

Through all the time that the earth is making one turn on its axis it is advancing around the sun in the same direction. So it takes this extra four minutes to bring the same meridian under the sun again, after making a complete revolution. Hence we have our solar day. Again, since the forward motion of the earth is not uniform, as well as for another cause, which is too intricate to mention here, the solar days are not, as we have said above, of equal length. So the device is adopted of ascertaining their average through the year and calling it the mean solar day. This, subdivided into hours, minutes, and seconds, is mean time—the clock-time of ordinary life.

If, therefore, it is desired to find correct time from a sun-dial, or by any method depending on the sun, the correction from apparent to mean time must be made. At four instants during the year this correction is zero. At other times a quantity, amounting at its greatest to about sixteen minutes, must be added to or subtracted from sun-time. For several days in the early part of November the sun is on the meridian more than a quarter of an hour before twelve o'clock. Our present system is not exact sun-time, but sun-time so modified as to be adapted to the current wants of our existence. It is uniform, because it is based on the time of revolution of the earth on its axis, which has not varied, if at all, more than one sixtieth of a second in the past twenty-five hundred years. But the common day is not the exact time of the earth's revolution, nor is the common year the exact time of its motion around the sun.

The tendency of civilization seems to be to depart from these strict

astronomical units, while all the time depending upon them for their ascertainment. And the recent changes of using "standard time" are in the same direction. Of course, every place, not just north or south of another, has a different noon. To prevent the confusion resulting from so many "times," our railroads have adopted as noon the mean times of certain standard meridians. These are taken just one hour apart, so that if the new time were universally adopted, the minute and second hands of all correct clocks would be the same over the whole United States, and the hour-hands would differ by one, two, or three hours. In England they have used Greenwich time over the island for many years, and our system is connected with theirs by using for our standard meridians those which are an even number of hours from Greenwich. In Philadelphia, for instance, which is situated on a standard meridian, the time is just five hours later; so that tidings of an event, happening at noon in London, if telegraphed immediately, will reach Philadelphia a few minutes after seven o'clock in the morning.

The objections to adopting this standard time, in some places, based on the inconveniences of having noon at some other time than when the sun is on the meridian, very much resemble those made in France when the Government substituted mean noon for apparent. In practice we never know when the sun is on the meridian, and if it gets there at 12.30 instead of 12, no one is the worse off, and the methods of living are readily adaptable to it.

Time being thus dependent on the facts of astronomy, its ascertainment is a part of the work of an astronomical observatory. The instrument used for the purpose is a transit-instrument. It consists of a telescope which is mounted, not to be pointed to any part of the sky, but to swing only in the plane of the meridian. It will point horizontally, north or south, to the zenith, and to intermediate points. A star in the east or west can not be seen by it. When it crosses the meridian, if the telescope is elevated to the proper angle, it will cross the field of view. To determine exactly what part of the field the meridian crosses, a spider-thread is stretched in the tube just in front of the eye-piece, which by a very accurate adjustment must be made to coincide exactly with the meridian. Just as the star crosses this thread, or, to speak more accurately, just as the particular meridian of the place passes under the star, the time must be recorded. As there is a possibility of an error in this, several spider-lines are inserted parallel to this central one, and symmetrically placed on either side.

The telescope is connected with an axis pointing east and west, working on the tops of two pillars set far enough apart to allow the telescope to swing between them.

Let us now go through the operation of "taking a transit." The observer, by means of graduated circles, points his telescope to the

place in the heavens where he knows the star is to cross. He has his clock or chronometer by his side ticking seconds or half-seconds. A little lamp sends a ray into the tube of the telescope, so that he can see the spider-lines. With paper and pencil in hand he stations himself in front of the tube. The star enters the field of view and moves toward the first spider-line. He glances at the clock, catches the time by the second's hand, and counts the ticks. Three—four—five—six—the star has just crossed a line. Estimating the *tenths* of a second, he records the time on the paper. All this while he is noting the beats of the clock, and, when the star reaches the second-line, he is ready to record another transit, and so on through. The mean of all these times is the time of crossing the central line *by the sidereal clock.* But in the "Nautical Almanac" this time is given accurately, and a comparison of the two shows his clock error.

Instead of recording the transits by the "eye-and-ear" method above described, there is an easier way by simply tapping the key of an electric circuit at the time of transit. This makes a record on a "chronograph," which can be read at leisure.

A chronograph consists of a brass cylinder, on which is fastened a sheet of paper. This is placed with its axis horizontal, and is revolved uniformly by clock-work. A pen rests with its point against the paper, making a mark around it. By a slight longitudinal motion this mark does not come around into itself, but advances a trifle, being like the thread of a screw, running from end to end. A current from a galvanic battery is so arranged that every swing of the second's pendulum causes an electro-magnet to attract the armature to which the pen is attached, and makes a break in the mark. Hence there is a series of breaks separated by intervals of a second. When the observer notes a transit, he, by his key, makes galvanic connection and interjects another break in the line. The position of this break among the seconds tells when the transit occurred, the fractions of a second being readily read.

He thus knows sidereal time; a little reduction gives him the mean solar time of the place of observation, from which the time at any other place whose longitude is known is directly deduced.

His telescope, to avoid all possibility of error, must be in perfect adjustment. The axis must be level; it must point east and west; his spider-line must be correctly placed in the tube; the pivots of the axis must be of equal size and uniformly round, and the axis must not bend under the weight of the tube. All these sources of error are carefully guarded against, but, as human powers are finite and disturbing causes very plentiful, errors will be introduced in various directions. So he seeks to nullify these by taking many stars in different parts of the sky, and from the varying errors he deduces what part belongs to the clock and what to the instrument. Should cloudy weather continue for many successive days and nights, he has to fall back on his

knowledge of the rate of his clock, which is kept under as uniform conditions of temperature and moisture as possible. There must be something radically wrong, either with the observer or his equipment, if he can not give the time of noon within a very few tenths of a second.

RECENT PROGRESS IN CHEMISTRY.*

By H. CARRINGTON BOLTON, Ph. D.,
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TO many intelligent and cultivated persons not specifically instructed in chemistry, this word recalls confused memories of colored liquids, glistening crystals, dazzling flames, suffocating fumes, intolerable odors, startling explosions, and a chaos of mystifying experiments, the interest in which is proportional to the danger supposed to attend their exhibition. Further reminiscences are of many singular objects in wood, metal, glass, and earthenware, of flasks and funnels, of retorts and condensers, furnaces and crucibles, together with bottles innumerable filled with solids, liquids, and gases, the whole paraphernalia connected by glass tubes of eccentric curves, and displayed in inextricable confusion and meaningless array. Behind this chaos arise vague memories of one discoursing learnedly in a polysyllabic jargon, and attempting to explain the unusual phenomena by the aid of abstruse hypotheses, but utterly failing to remove the sensations of awe and of mystery bordering on the supernatural which overwhelm the hearer—impressions that have clung to chemistry ever since its entanglement with the superstitions of alchemy, astrology, and the "black art."

Persons who undertake to gain through chemical literature a knowledge of what chemists are doing in and for the world encounter a discouraging nomenclature which repels them by its apparent intricacy and its polysyllabic character. Their opinion of the terminology of an exact science is not enhanced when they learn that "black-lead" contains no lead, "copperas" contains no copper, "mosaic gold" no gold, and "German silver" no silver; that "carbolic acid" is not an acid, "oil of vitriol" is not an oil, that olive-oil is a "salt," but "rock-oil" is neither an oil nor a salt; that some sugars are alcohols, and some kinds of wax are ethers; that "cream of tartar" has nothing in common with cream, "milk of lime" with milk, "butter of antimony" with butter, "sugar of lead" with sugar, nor "liver of sulphur" with the animal organ from which it was named.

Readers of chemical writings sometimes fail to appreciate the advantages of styling borax "di-meta-borate of sodium," or of calling

* From an address read before the New York Academy of Sciences, March 15, 1886. Revised by the author.

common alcohol "methyl-carbinol," and they ignore the euphony in such words as pentamethyldiamidothiodiphenylamindiiodomethylate (a substance begotten and baptized by Dr. Albert Maasen).

Those whose chemical education consisted in attendance on a course of lectures illustrated by experiments performed in their presence, interspersed with occasional recitations from a prosaic text-book which taxed the memory in true Chinese fashion, may be pardoned for retaining very hazy impressions of the true character of the science. On the other hand, many thinking and reading persons recognize the magnitude of the scope and operations of chemistry, and have some appreciation of its benefits to mankind.

The fields of chemistry explored by zealous investigators are prodigious in extent and diversity; in its various sections, analytical, agricultural, pharmaceutical, physiological, and technological, it yields fruit of infinite value to the human race, and, co-operating with other sciences, produces results which promote civilization in the highest degree. So rapidly are new methods of cultivation applied to these fields, so numerous and active are the workmen engaged in tilling them, that the harvest is too abundant for mental storage, and those who survey the operations at a distance are quite unable to apprehend the products. This inability to follow the advances made by chemical science is felt not alone by those whose imperfect and non-technical training has illy fitted them for the task; even the specialist stands aghast at the prospect, and, abandoning attempts to apprehend the progress made in all departments, confines his reading and research to a limited number.

The twelve principal chemical societies of the world have an aggregate membership of nearly nine thousand;* almost all of these members are actively contributing to the advancement of chemical science, publishing their results for the most part in periodicals especially devoted to the subject. Excluding transactions of societies and journals

* The membership in these societies is distributed as follows:

Deutsche chemische Gesellschaft zu Berlin	2,950
Society of Chemical Industry (England)	2,400
Chemical Society of London	1,500
Société chimique de Paris	560
Institute of Chemistry of Great Britain and Ireland	430
American Chemical Society	250
Society of Public Analysts (England)	180
Chemical Society of St. Petersburg	160
Associazione chimico-farmaceutica fiorentina	*200
Chemical Society of Tokio, Japan	86
Chemical Society of Washington, D. C.	48
Association of Official Agricultural Chemists (U. S. A.)	17
Total	8,781

* Estimated. Many chemists are members of several of the above societies, but against this duplication may be set those not connected with societies.

of physics and pharmacy, these chemical periodicals issue annually about twenty thousand pages. Bearing these statistics in mind, are we not justified in feeling appalled at the idea of presenting within the compass of an evening's address a review of recent progress in chemistry? Any attempt to do more than glance at a few salient points is obviously out of the question. "Recent" time will of necessity be a somewhat variable quantity, its limits being determined by expediency. We shall also endeavor to bear in mind the fact that we address an audience not exclusively composed of professional chemists.

Much interest is commonly attached to announcements of new forms of matter—an interest out of proportion, perhaps, to the real value of the discoveries. During the last nine years chemists have not failed to sustain this interest, for they have proclaimed no less than thirty-four new elementary bodies. The ambition of these chemists, however, has been greater than their accuracy, for of these thirty-four bantlings but five or six have survived the scrutiny of the doctors, two or three are now in precarious health, and the remainder have been cremated without ceremonies. Of the youthful survivors comparatively little is known; their character is being severely tested, and their future destiny and utility are yet uncertain. The extreme rarity of the minerals in which the new elements have been detected, the excessively small percentages of the new ingredients, the extraordinary difficulties attending their separation from known substances combine to render the investigations laborious, protracted, and costly. From twenty-four hundred kilogrammes of zinc-blende, Lecoq de Boisbaudran, the discoverer of gallium, extracted sixty-two grammes of the precious metal; compared with this element, therefore, gold is both abundant and cheap. Ytterbium, scandium, samarium, thulium, and the rest, will long remain mere chemical curiosities known to but few; probably the most sanguine will not claim for them a future place among substances of economic value.

But of far greater importance than the elements themselves is the marvelous delicacy of the means used in detecting and isolating them. When Bunsen and Kirchhoff presented to scientists the instrument which combines the penetration of a telescope with the power of a microscope magnified a hundred-fold, they were enabled to disclose Nature's most hidden secrets. The new elements have been traced to their hiding-places, their differences established, and their subsequent purity demonstrated, chiefly by their emission and absorption spectra. Three years ago, William Crookes, who had already discovered thallium by the aid of the spectroscope, announced a novel and remarkable extension of the power of this instrument. Crookes found that many substances, when struck by the molecular discharge from the negative pole in a highly rarefied atmosphere, emit phosphorescent light of varied intensity. Having observed under these conditions a bright citron-colored band or line, he pursued the substance producing it, and,

after a laborious search, found that it belonged to yttrium. Subsequent studies showed this modification of spectrum analysis to exceed in delicacy all known tests for the rarer earths; yttrium can be detected when present in one millionth part. Within a twelvemonth, Crookes has made known the application of radiant matter spectroscopy to samarium; the delicacy of this test surpasses that for yttrium, and the anomalous behavior of the mixed earths yields phenomena "without precedent."

When Dalton, the Manchester schoolmaster, added to the atomic theory of the Greeks the laws of definite and of multiple proportions, he transformed an "interesting intellectual plaything" into an exact scientific theory capable of experimental demonstration. The importance of ascertaining the atomic weights of the elements with the utmost accuracy has stimulated chemists to apply to the problem their best endeavors; and as the methods of analysis become more refined, the determinations are again and again repeated, every ascertainable and imaginable source of error being carefully eliminated. Besides the experimental repetitions, the figures obtained by various observers have recently been submitted to careful recalculations by Clarke in this country, and soon after by Lothar Meyer and Seubert, in Germany. Their labors give chemists the latest and most reliable constants.

For many years chemists have dimly perceived the probable correlation of the properties of the elementary bodies and their atomic weights. Dumas pointed this out for certain marked groups, Newlands emphasized it; but it remained for a Russian chemist, Mendelejeff, to establish, in 1869, a law of great importance. Mendelejeff showed that if the elements are grouped in the order of their atomic weights, it will be found that nearly the same properties recur periodically throughout the entire series. This so-called Periodic Law is more concisely stated thus: The properties of the elements are periodic functions of their atomic weights. The accuracy of the deductions based on this law is strikingly shown by the fact that Mendelejeff, finding an unfilled blank in the periodic system, boldly announced the general and special properties of the element awaiting discovery; six years later, Lecoq de Boisbaudran discovered gallium, an element which proved to have properties almost identical with those of the hypothetical *eka-aluminium* described by Mendelejeff. And in 1879 the accuracy of Mendelejeff's prophecy was further confirmed by Nilson's discovery of scandium, the counterpart of the hypothetical *eka-bor*. *Eka-silicon*, though yet to be discovered, may almost be regarded as a known element, so fully have its properties been predicted.

The correlation between atomic weights and physical properties is being extended, and now embraces the fusibility, boiling-points, general affinities, color, occurrence in nature, physiological functions, and many other factors. Dr. Carnelley, who has been active in develop-

ing this subject, at the Aberdeen meeting of the British Association, proposed a "reasonable explanation" of the periodic law; he regards the elements as compounds of carbon and æther, analogous to the hydrocarbon radicals, and suggests that all known bodies are made up of three primary elements—carbon, hydrogen, and æther—an assumption which can not be disproved. In recent years the periodic system has exerted noteworthy influence on the classification of the elements and their compounds. It is of positive utility in determining unsettled questions concerning new and rare elements, and is destined to maintain a lasting hold on chemical philosophy.

The question whether the known elements are truly primary forms of matter has long occupied the thoughts of chemists, and the problem constantly acquires new features. The influence of high temperatures on the spectra of the metals has been a fruitful source of speculations. In 1878 the English astronomer and physicist Lockyer announced the discovery of the resolution of the elements into one primary matter; but when Lockyer's paper was read before the Royal Society his discovery proved to be little more than a hypothesis, and that not a new one, he having been virtually anticipated by Professor F. W. Clarke, of Washington. However, Lockyer's hypothesis was based in part upon experimental evidence. After eliminating coincidences in the lines of the spectra of various metals, due to impurities, so large a number of identical lines remained that he advocated the assumption that these are produced by a primary matter common to the so-called elements. He pointed out that in the hottest stars, Sirius for example, hydrogen only is present, and argued that at extremely high temperatures the so-called elements are broken up into hydrogen, the ultimate matter of the universe. Lockyer's announcement excited, temporarily, a lively interest, but his views are not regarded as supported by sufficient evidence.

More recently, the doctrine of "structure" has been borrowed from organic chemistry, and applied to the elementary bodies; the relations existing between the elements is so similar in many respects to the relations between the hydrocarbons in a homologous series that the elements have been regarded as compounds of carbon with an unknown primary form of matter. Experimental evidence is lacking, but the hypothesis takes a plausible form.

During the past year an Austrian chemist has announced the decomposition of didymium by purely chemical means, and the discovery of praseodymium and neodymium as its constituent elements. An English chemist claims to have evidence of the existence of an allotropic form of nitrogen. Both these statements await confirmation.

The views of chemists concerning the nature of affinity and chemical action are undergoing modifications destined to wield an important influence on the science in the near future. The notion has prevailed, though not distinctly formulated, that the chemical attraction exerted

between unlike atoms is a superior sort of cohesion, powerful and absolute; and this force was thought to operate between two elementary bodies directly, without the intervention of a third kind of matter. That this so-called affinity is radically affected by physical state, by heat, and by electricity, has been admitted, but the conviction is growing in the minds of chemists that many circumstances influencing the union and separation of elements have been overlooked; they are beginning to believe that chemical action does not take place between *two* substances, and that the presence of a third body is important, if not, indeed, indispensable. Many years ago the word catalytic was coined to describe certain isolated phenomena little understood. These phenomena are familiar to chemists, and the number is increasing; the word catalytic is, however, in disfavor, and the term contact-actions is now current. The well-known influence of finely divided and heated platinum in effecting the union of sulphur dioxide and oxygen and the action of metallic silver in decomposing ozone without itself undergoing any change are examples. In these and similar changes one of the substances indispensable to the reaction remains unchanged, and its *rôle* can not be expressed in equations.

There is another class of reactions in which one body acts upon another only through the aid of a third, which maintains its identity at the close of the reaction, yet is known to be decomposed and recomposed successively throughout the operation. By heating a relatively small quantity of cobaltous oxide with bleaching-powder, the latter is wholly decomposed, yielding calcium chloride, water, and oxygen, yet at the close of the reaction the cobaltous oxide is found unaltered. It has been shown that it is successively decomposed and recomposed during the operation. In their investigation on "Simultaneous Oxidation and Reduction by means of Hydrocyanic Acid," Professors Michael and Palmer consider it probable that many of the most important reactions of animal and vegetable life are due to the intercession of substances which undergo change during the reactions, and in the end return to their original form. They suggest also that some of these reactions seem to be dependent on substances capable of decomposing water into its elements, or into hydrogen and hydroxyl; and, when the chemist can command a reagent possessing that property at a low temperature, their imitation in the laboratory may follow its discovery.

That chemically pure zinc is not soluble in dilute sulphuric acid has been known since Faraday's day; that sodium does not combine with perfectly dry chlorine, even if the metal be heated to its fusing-point, was shown by Wanklyn in 1869; more recently, Mr. Cowper has found that dry chlorine does not attack Dutch metal; six years ago, Mr. H. B. Dixon demonstrated before the British Association that a well-dried mixture of carbon monoxide and oxygen can be subjected to the electric spark without exploding. In March, 1885, Mr.

H. B. Baker communicated to the London Chemical Society results of his experiments on the influence of moisture in the combustion of carbon and of phosphorus in oxygen, his conclusions being that the combustion of dry charcoal in dry oxygen is incomplete and slower than in ordinary moist oxygen. In the discussion which followed Mr. Baker's paper, Dr. Armstrong pointed out the importance of these new facts in defining more accurately conceptions of chemical action, and suggested that chemical action is "reversed electrolysis." In his address as President of the Chemical Section of the British Association for the Advancement of Science (September 10, 1885), Dr. Armstrong further discussed this subject, and stated that the idea conveyed by the expression "reversed electrolysis" is found in the writings of Faraday, neglect of whose teachings retards the progress of chemistry.

Liquefied ammonia at −65° does not combine with sulphuric acid, but swims on its surface without mixing with it. Donny and Mareska long ago showed that sodium retains its luster in liquid chlorine at −80°, and quite recently Professor Dewar demonstrated that liquid oxygen is without action on sodium, potassium, phosphorus, solid sulphuretted hydrogen, and solid hydriodic acid. He further experimented with other substances normally active, and found their affinity at very low temperatures destroyed.

The speed of chemical reactions is an important factor in chemical theory, the study of which has but recently begun. Wenzel long ago held that the affinity of metals for a common solvent, such as nitric acid, was inversely as the time necessary to dissolve them, and he experimented with small cylinders partly protected by wax. Gladstone and Tribe have made attempts to ascertain the rate at which a metallic plate precipitates another metal from a solution, and they announced a definite law. Professor John W. Langley has since shown that, while their experimental work was correct, their method was faulty, and the results fallacious; he thinks it probable that the true law of chemical action where one metal precipitates another should be thus stated: The time during which one atom replaces another in a compound molecule is constant, and the total rate of chemical action varies directly as the mass of the reacting body in solution.

In his address before the Chemical Section of the American Association for the Advancement of Science, at Philadelphia, Professor Langley discussed the problems of chemical dynamics, and pointed out the rich store of promise in this neglected field. Physics deals with three quantities—space, mass, and time. Chemistry has too long been content with studying the changes of matter in terms of space and mass only—that is to say, in units of atomic weight and atomic volume. The discovery of a time-rate for the attractions due to affinity is destined to throw new light on chemical science, and to render it capable of mathematical treatment.

A prodigious amount of work has been done in thermo-chemistry,

and within a few years the multitude of isolated observations have been collected, classified, and made available. The importance of this undertaking will be more appreciated in the future than it has been in the immediate past. In all cases of chemical change, energy in the form of heat is either developed or absorbed, and the amount is as definite in a given reaction as are the weights of the substances concerned; hence, measurement of the quantity of heat set free or absorbed in chemical reactions often enables the chemist to determine the true nature of the change. For example, the exact condition of certain bodies in solution can only be conjectured from certain physical characters, few and ill-defined; but by thermic methods of investigation the bodies formed can be accurately ascertained. This is accomplished by reference to the law of maximum work: "In any reaction, those bodies, the formation of which gives rise to the greatest development of heat, are formed in preference to others." Thus the thermometer alone in skillful hands determines the *a priori* necessity or impossibility of a reaction.

Berthelot, in Paris, and Thomsen, in Copenhagen, have pursued the subject of thermo-chemistry with indefatigable zeal, and their published results form monuments of exhaustive research. "By the labors chiefly of these two men, we now know the thermal values corresponding to many thousands of chemical reactions. We have learned that the energies of a reaction which can be brought about in two methods, either in the dry way or by solution, differ in the two cases; that salts in solution are in a partial state of decomposition; that the attraction of a polybasic acid radical is not the same for the successive portions of base added, and that the behavior of a monobasic acid in solution differs essentially from that of a dibasic or tribasic acid. We also know that the total energy involved in any reaction is largely influenced by the surrounding conditions of temperature, pressure, and volume."

The interesting border-line between chemistry and physics is an increasing subject of research on the part of both the chemist and the physicist. The periodic press chronicles profound studies of the relations between chemical constitution and the phenomena of diffusion, of capillarity, of dialysis, of dissociation, and of the law of isomorphism. We read investigations on the value of the theory of atomicity, and on the nature of nascent action. Researches in the domain of electro-chemistry, especially in connection with the various forms of storage-batteries, and in relation to the methods and results of electrolysis, are of such importance as to merit a whole address. The press also records numerous studies in actinometry, of the relations between chemical composition and fluorescence and phosphorescence, as well as of polychroism, and of the results of spectrum observations. Noteworthy are the special applications of optical methods to the determination of molecular structure, viz., the relations between chemical composition

and (1) the refractive power; (2), the power of rotating a ray of polarized light; and (3), the absorption spectra of both inorganic and organic bodies.

The meeting of the French Academy of Sciences, held the day before Christmas, 1877, was rendered memorable by the announcement that oxygen gas had been liquefied by two independent experimenters. Previous to that date, hydrogen, oxygen, nitrogen, nitric oxide, marsh-gas, and carbon-monoxide had resisted all attempts to liquefy them, whether in the hands of the skillful Faraday, the ingenious Natterer, or the learned Andrews. Physicists and chemists, while admitting the class of so-called permanent gases, had for many years looked forward to their eventual liquefaction, yet the final success came as a surprise. This success was the result of the enterprise and ingenuity of a French iron-master, M. Cailletet, and of a Genevan manufacturer of ice-machines, Raoul Pictet, working independently. In each case, the process consisted in simultaneously exposing the gases to a very high pressure and a very low temperature. Pictet obtained the necessary pressure by generating the oxygen in a wrought-iron vessel strong enough to withstand an enormous strain, and the low temperature was secured by the rapid evaporation of liquid carbonic acid; Cailletet, whose apparatus was marked by extreme simplicity, obtained the great pressure by means of a hydraulic press, and the low temperature by suddenly diminishing the pressure upon the compressed gases. Descriptions of apparatus without diagrams are seldom intelligible; in this place they are superfluous, for we deal with results rather than with methods. Being ignorant of the "critical point" for oxygen, both experimenters employed a much greater pressure than necessary.

Since the initial successes, the problem of liquefying the quondam permanent gases has been successfully attacked by several experimenters, especially by Wroblewski and Olzewski, whose names indicate their nationality. By employing liquid ethylene (which boils *in vacuo* as low as −150° C.[−238° F.]) as a means of cooling the gases under pressure, both oxygen and nitrogen, as well as atmospheric air, have been liquefied at very moderate pressures.

Among the interesting results obtained are the following: at −102° C. (−152° F.), chlorine forms orange-colored crystals; at −115° C. (−175° F.), hydrochloric acid is a solid; at −118° C. (−180° F.), arsine forms white crystals; at −129° C. (−200° F.), ether solidifies; at −130° C. (−202° F.), absolute alcohol solidifies; at −184° C. (−299° F.), oxygen boils; at −191·2° C. (−312° F.), air boils; at −205° C. (−337° F.), air boils *in vacuo*. These extraordinary temperatures were measured by means of a hydrogen thermometer and by a thermopile. The lowest temperature measured (to date) is −225° C. (−373° F.), which was reached by reducing the pressure of solid nitrogen to 4 mm. mercury (Olzewski). Further noteworthy results are as follows: Nitrogen was obtained in "snow-like crys-

tals of remarkable size"; the liquefaction of air has been so conducted as to obtain two distinct liquids separated by a perfectly visible meniscus (Wroblewski); and, finally, when hydrogen was subjected to between 100 and 200 atmospheres pressure in small glass tubes surrounded by oxygen boiling *in vacuo*, it condensed to colorless drops.

These noteworthy results are triumphs of physics rather than of chemistry, but no review of chemical progress can afford to omit them; their bearing on the molecular theory of matter justifies the space given them. It seems probable, moreover, that every known substance on the face of the earth will be eventually obtained in solid form by the mere withdrawal of heat. At these low temperatures the chemical activity of bodies is greatly lessened or ceases, but additional observations must be made on this point before attempting generalizations.

Experiments of the character described demand great resources and are not devoid of danger; those conducting them will be rewarded by undying fame.

The progress of chemistry, in its more material aspects, is characterized by the improved and economic production of known substances, by the discovery and manufacture of entirely new ones, and by novel applications of both these classes as well as of waste materials. The necessity of utmost condensation precludes enumeration of even a centesimal part of the processes and products, nor would the mere catalogue be profitable. Omitting for the present the prolific department of organic chemistry, brief mention may be made of improvements in the metallurgy of nickel (now known to be malleable and ductile), of attempts to cheapen the production of aluminium, of the revival of the barium-dioxide process for manufacturing oxygen on a large scale, of novelties in artistic keramics, of the industrial production and application of the rare metal vanadium, of the successful introduction of water-gas as an illuminating agent, and of constant activity in the fascinating field of photography.

No chemical manufactures are more important than those grouped under the name "alkali industry," which comprises the production of those adjuncts of civilization, carbonate of soda, caustic soda, bicarbonate of soda, and bleaching-powder. Conducted by the methods originated by the ill-fated Nicolas Leblanc, they have, after a century's successful career, begun to give way to a youthful rival. The struggle to maintain the supremacy of Leblanc's process has been severe, the problem being a purely financial one. At first, the profits were made exclusively on the soda; then the decreasing profits, as well as the necessity of condensing the torrents of hydrochloric acid, led manufacturers to add to the production of alkali that of bleaching-powder, and the latter then yielded the profits, while the soda became a by-product. Sharp competition in England and France pushed prices below profitable production, and capitalists with millions in-

volved found their chemical ingenuity severely taxed. Various economical methods of recovering waste by-products were adopted, and finally attention was turned to the "burned ore" or "pyrites-cinders" obtained in roasting pyrites for the sulphuric acid; this is now treated for copper, silver, and, to some extent, for gold. A Spanish company, owning enormous deposits of pyrites on the Rio Tinto, plan to establish in France alkali-works with the intention of deriving their profits solely from the residual oxide of iron and the copper.

Forty-eight years ago alkali manufacturers might have seen a cloud arising, no bigger than a man's hand, which gradually grew darker and heavier, and now threatens to overwhelm the Leblanc process. Dyer and Hemming patented the so-called "ammonia process" for manufacturing soda in 1838; Schlössing and Rolland attempted to carry it out practically in 1855, but it was not found profitable. The credit of overcoming the practical difficulties, and placing the process on an economical basis, belongs to Solvay, of Brussels, who began to manufacture so-called "ammonia-soda" in 1866. Commencing with the modest yield of 179 tons in that year, he increased it in ten years to 11,580 tons, and in 1883 about forty per cent of all the soda made on the Continent was produced by the ammonia process. The success of the new process has completely killed the Leblanc method in Belgium, and has caused the closing of many works in England. A drawback to the new process is that no hydrochloric acid is produced, yet chloride of lime is always in demand; hence a high authority, Dr. Lunge, thinks that in the future the two processes will, of necessity, exist side by side. Mr. Rowland Hazard and others, having secured the right to work under Solvay's patents, have established a manufactory at Geddes, near Syracuse, New York. The estimated production of these works for 1886 is thirty million kilos, and the soda obtained is of great purity. It will be interesting to watch the future of this industry in America.

In modern chemical literature by far the greatest amount of space is occupied with researches and discoveries in organic chemistry. To the non-professional reader the peculiarly technical language, abounding in words of unusual length, is not only incomprehensible, but positively forbidding. A vocabulary which contains such terms as toluyldiphenyltriamidocarbinol acetate and methylorthomonohydroxybenzoate does not encourage the casual reader; and when he learns that the first-named body is the dye-stuff commonly called magenta, and that the second is the innocent oil of wintergreen, surprise gives way to feelings of despair. When one is gleefully informed that a distinguished foreigner has discovered that orthobrombenzyl bromide treated with sodium yields anthracene, which, heated with nitric acid, yields anthraquinone, and that anthraquinonedisulphonic acid fused with potassium hydroxide furnishes dioxyanthraquinone, the lay hearer can hardly be expected to become enthusiastic over the announcement,

and yet these operations conducted in the private laboratory of a man of genius have been of direct benefit to mankind, setting free thousands of acres for the production of breadstuffs, and establishing industries employing a multitude of workmen. In a word, these abstruse phrases describe the artificial production of alizarine, the valuable coloring-matter of madder.

The polysyllabic nomenclature now prevailing expresses to the chemical mind the innate structural composition of the body named; of late years the words are formed by joining syllables to an almost indefinite extent, and a distinguished chemist has recently urged the advantages of empiric names in place of the unwieldy system. Whether Dr. Odling's plea will produce a reaction in favor of empiric names remains to be seen.

To enter into details concerning the recent progress of organic chemistry, and to make them intelligible to an audience not composed of well-read professional chemists, is an undertaking of doubtful success; we shall content ourselves chiefly with generalities.

That remarkable product of nature, petroleum, continues to occupy the studies of chemists at home and abroad. Newly invented methods of fractional distillation have disclosed previously unsuspected constituents and peculiarities. Lachowitz has found in the petroleum of Galicia several members of the aromatic series; Mendelejeff has noticed abnormal relations between the specific gravity and boiling-points of successive fractions in distilling American petroleum. The various commercial products from crude petroleum, rhigolene, vaseline, paraffin, etc., continually find new and useful applications, their names being household words.

The industrial and scientific novelties in the important groups of oils and fats, alcohols, and acids, can not be specified. After cane-sugar, glucose is receiving the most attention; in the United States and Germany are sixty manufactories of the various grades of starch-sugar, the annual home production alone being valued at ten million dollars. Glucose is extensively used as a substitute for cane-sugar in the manufacture of table-syrup, in brewing, in confectionery, in making artificial honey, and in adulterating cane-sugar, as well as in many minor applications. Recent experiments by Dr. Duggan, of Baltimore, show that glucose is in no way inferior to cane-sugar in healthfulness. Much work has been done on sorghum by Dr. Peter Collier, and the first complete examination of maple-sugar has lately been made by Professor Wiley, of the Department of Agriculture. Lovers of the latter sweet will be pleased to learn that it can be made by adding to a mixture of glucose and cane-sugar a patented extract of hickory-bark which imitates the desired flavor.

The great demand for high explosives as adjuncts to engineering, mining, and military operations, occasions constant experimentation; besides the invention of mere empiric mixtures of known substances,

chiefly nitro-compounds, much work is done of a purely scientific nature, such as investigations on the chemical reactions and products of explosive mixtures, on the heat disengaged by their explosion, on the pressure of the gases produced, and on the duration of the explosive reaction. Thanks to the "Notes" of Professor C. E. Munroe, of the United States Naval Academy, chemists are informed of the freshest novelties in this department, rendering further mention superfluous.

The researches of chemists in the aromatic series outweigh in both number and importance those in all other sections. The once despised refuse coal-tar has created an entirely new chemistry, and, in its products and derivatives, is by far the most promising field for investigators. The compounds of the aromatic series have afforded some of the most notable successes in synthetical chemistry, as well as some of the most useful substances for dyeing, for hygienic and medicinal purposes. The oil obtained in the dry distillation of bones, a subject of classic investigations by Anderson, of Glasgow, forty years ago, has recently acquired new interest; one of its constituents, pyridine (C_5H_5N), has been obtained in several ways which show that it bears the same relation to certain acids derived from natural alkaloids, such as quinine, nicotine, etc., that benzene does to benzoic and phthalic acids. These facts point to the possible artificial preparation of quinine at no distant day. This view of the constitution of the alkaloids is confirmed in many ways, notably by Ladenburg's discovery that piperidine, a base occurring in pepper, is hexahydrobenzene.

Professional chemists also acknowledge the marvelous success in unraveling the complications of isomerism, and the important aid afforded the study of isomeric bodies of the aromatic group by the doctrine of *orientation*. These rather technical details can receive, however, but brief mention, though a whole series of lectures could be devoted to the fascinating topic. Leopold Gmelin, when writing his "Hand-book of Chemistry," in 1827, requested organic chemists to stop making discoveries, or else he could never finish! And during the sixty years which have elapsed the activity in organic chemistry has been unceasing; yet the extraordinary number of facts now known is not so great as those which the prophetic eye sees disclosed by recently revealed lines of investigation.

The crowning glory of chemistry is the power of producing, in the laboratory, from inorganic matter, substances identical with those existing in the vegetable and animal kingdoms. Belief in the mysterious vital force operating in living beings received a rude shock at the hands of Wöhler, sixty years ago, and successive triumphs in synthesis have dispelled it entirely, so far as non-organized bodies are concerned: "To-day we know that the same chemical laws rule animate and inanimate nature, and that any definite compound produced in the former can be prepared by synthesis as soon as its chemical constitu-

tion has been made out." Within a few years chemists have announced the synthesis of many acids, essential oils, alkaloids, glucosides, dye-stuffs, and other bodies naturally occurring in the organic world, and so rapidly do these announcements succeed one another that expectation has displaced surprise. Noteworthy are the following: Alizarine, the valuable coloring-matter of madder; vanilline, the aromatic principle of the vanilla bean; cumarine, the aromatic principle of the Tonka bean; indigo, the well-known dye-stuff; uric acid, an animal product; tyrosin, likewise a product of the animal organism; salicine, daphnetine, and umbelliferone, natural glucosides and related bodies; piperidine, a constituent of pepper; and cocaine, the new anæsthetic. Besides these, many syntheses have been accomplished of bodies isomeric and not identical with the natural products.

The alchemists labored to transmute base metals into noble ones, and were destined never to realize their ambitious designs; modern organic chemists, operating on substances compared with which even the base metals are precious, produce articles more beneficial to mankind than gold itself, and, at the same time, gain, indirectly, no small store of the coveted metal.

The application of chemistry to physiology encounters the most complex and difficult problems in the science, and at the same time aims to accomplish the most beneficent results. "The physiologist complains that probably ninety-five per cent of the solid matters of living structures are pure unknowns, and that the fundamental chemical changes which now occur during life are entirely shrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted." It may seem strange to the non-professional in this audience that, in spite of persistent and skillful attempts to solve the problem, chemists are obliged to admit ignorance of the exact composition of so common a substance as the white of egg; yet, until they acquire an accurate knowledge of the constitution of albuminous substances, the processes of animal economy can not be explained. While the physiologist, in some degree, waits on the organic chemist for further developments, the latter discovers and prepares novel bodies much faster than the physiologist ascertains their influence on the animal economy. To the joint labors of chemists and physiologists are due the blessings of anæsthetics, hypnotics, and other conquerors of suffering and disease. The anæsthetic properties of cocaine, and the circumstances of their discovery, are matters of popular knowledge. Within a twelvemonth, ethyl-urethane has been added to the list of hypnotics.

In recent years sanitary chemistry has acquired great importance, and now occupies a distinctly defined field, including all that pertains to the hygienic value of foods and beverages, their adulterations, and their fraudulent substitutes; questions of gas and water supply; of the uses and abuses of disinfectants; of household ventilation, and of

the diverse matters grouped under the term chemical engineering. Of this very practical branch of chemical science, as well as of the valuable additions to materia medica, of the improved methods introduced into analytical chemistry, and of the contributions to the chemistry of agriculture, no mention can be attempted.

The tendency of modern researches in chemistry is to magnify the atomic theory; the rapid accumulation of facts, the ever-increasing ingenious hypotheses, the most searching examinations of co-ordinate laws, all tend to strengthen the Daltonian adaptation of the philosophic Greeks. Here and there a voice is raised against the slavish worship of picturesque formulæ; but, against the molecular theory underlying the symbolic system so depicted, few earnest arguments are advanced. The whole aim of organic chemistry is directed to the discovery of the arrangement of atoms within the molecule, and the success obtained justifies the hypothesis. The edifice erected through these achievements, though young in years, is too substantial to tolerate displacement of its corner-stone. The absolute truth of the atomic theory is beyond man's power to establish; even admitting that it necessitates absurd assumptions, it is, nevertheless, indisputably the "best existing explanation of the facts of chemistry as at present known."

A noteworthy feature of existing chemical research is the recognition of the necessity of a more intimate knowledge of the connection between physical characters and chemical constitution. In the past chemists increased the number of new compounds so rapidly that they often neglected detailed examination of their physical properties, their relations to known bodies and to each other, preferring to satisfy their ambition by fresh discoveries. This race after new bodies still continues, but parallel with it are zealous investigators striving after a knowledge of the innate qualities and bearings of these same bodies; and the latter class of students is gaining prizes no less valuable than those secured by the former.

Chemists are also recognizing the necessity of a more minute study of the simpler phenomena of chemistry, and it is in this direction that they look for many laurels in the future. Priestley's day of great discoveries by the simplest means has in one sense passed; the opportunities for isolating nine new gases, or of recognizing by chemical tests half a dozen new elementary bodies, in the space of a lifetime, are gone; only by the employment of the most delicate appliances, by the closest scrutiny of phenomena and the conditions governing them, by availing themselves of all the resources of physics, by an unshrinking expenditure of time and of money, to say nothing of the necessity of trained mental powers of no low order and of skilled hands, shall chemists in succeeding generations realize their ambitious designs.

THE PREDICTION OF NATURAL PHENOMENA.*

By Dr. ARNOLD SCHAFFT.

ALTHOUGH those times have gone by which oracles and soothsayers played an important part, yet even at the present day prophets are to be found almost everywhere. We will not speak here of politicians, of those that predict peace and war, nor of speculators and the so-called reformers, with their predictions in the domain of commerce and industry. We shall confine ourselves to the discussion of natural phenomena—not alone to those that are grand and striking, but shall in preference turn to the common occurrences of every-day life.

"What weather are we to expect within the next few days?" Only put the question, and a hundred answers will be volunteered. The curing of all diseases is often predicted by quacks and patent-medicine men with a degree of assurance scarcely to be believed. "This remedy never fails," is the superfluous winding-up of many an advertisement of their nostrums, and thousands of credulous people daily fill the pockets of these charlatans.

A considerable number of those persons who do not permit themselves to be thus caught err in the opposite direction—that is to say, they regard *all* predictions with mistrust. For instance, they attach but little importance to any of the attainments of medical science; they doubt the usefulness of meteorological stations, etc. And yet even skeptics like these must acknowledge that nnmerous astronomical predictions come true with a degree of precision and accuracy that must astonish every one.

What prophecies, then, are to be believed? The predictions of science? Alas! how many supposed scientific predictions have proved to be mere delusions! The word "science" will not answer in this connection. Is there, then, no standard by which the value of predictions of natural phenomena may be gauged or measured?

A standard exists, and may be determined by an acquaintance with the elements of inductive logic, and with the most important teachings of natural science. Considering the wide-spread interest that attaches to this question, it will be worth while to study the subject a little more closely.

Almost every prediction requires some statement admitted to be universally valid, from which it may be deduced. If one desires to know how probable a prediction is, it will be well to test it by the following questions: Does the prediction rest on simple enumeration?

* Translated and condensed from Virchow and Holtzendorffer's "Sammlung gemeinverständlicher wissenschaftlicher Vorträge" ("Collection of Popular Scientific Lectures").

Is it based on the general law of causation? Does it presuppose the acceptance of any theory?

Predictions and generalizations based on Bacon's system of induction and simple enumeration are the most common and best known; they are based on the observation of Nature *without experiment.* They take the facts as they are, and merely enumerate. This method governed the whole world before the development of natural science. Even to-day it is made the basis of prediction by all who are not familiar with the method of experimental investigation. In this category must be classed the sayings of country people purporting to foretell the weather. If a farmer who places faith in such sayings be asked upon what grounds his belief is founded, he will probably answer, "For so and so many years I have watched the weather, and have always known these rules to come true." At the best, his observations will have been none too accurate; and as to any actual relation between prediction and fulfillment, of course that is out of the question.

Even nowadays many families cling to the superstition that thirteen people should not be seated together at table, because it is a sign that one of the number will die in the coming year. Should any question be asked as to the *reasons* on which such a fear might be founded, a great many incidents will undoubtedly be related, instances where thirteen dined together, and death claimed a victim from among the number before the year had passed. The many occasions where thirteen have dined together and no one of the number has died within the time prescribed (and how often does this not occur in inns and other public places, and no one gives the matter a thought!), these instances are of course completely ignored. A patient, who may have consulted several physicians without experiencing relief, finally turns to one of the many patent-medicines advertised in the papers. After a time he feels better; perhaps the improvement is but temporary, as is so often the case in troubles of long standing, but then, oftentimes urged thereto by the proprietors of the wonderful medicine, he writes a letter of thanks, and anon the papers will herald the announcement, "Sure cure to all unfortunates by the famous cure-all, ——," and then comes some pompous name. Other patients think a great deal of the so-called "sympathetic" cures. When the moon is on the wane they go to a graveyard, taking care to speak to no one on the way, or they throw barley-grains over their head backward into the water, meantime muttering some incantation. If the believers in these cures be questioned as to how they can place faith in such wondrous arts, they will refer to certain instances where such means have been successfully employed; but of course they can trace absolutely no connection whatever between the remedy and its supposed effects.

Prophecies of a similar kind, that do not, however, exactly refer to natural phenomena, can only be mentioned here. Thus, a northern light or a comet is said to be the forerunner of war. The relative position

of certain stars at the birth of a child is, by the superstitious, said to bode good or evil. If a new piece of work be commenced while the moon is on the wane, or on a Friday, the undertaking is doomed to fail. The belief in good and evil omens has survived thousands of years, and has come down to the present day; in fact, the influence which this belief has on the mind can only be shaken off by calm reasoning and self-training. Many other instances of superstition, still in vogue in our enlightened times, might readily be given.

All of these are false conclusions derived in the same manner: *post hoc, ergo propter hoc* (after it, therefore because of it). A careful comparison of different cases is not undertaken, no close scrutiny or investigation is attempted, no distinction made between essential and non-essential conditions. In each case a general assertion is based on a few separate, consecutive facts; the relation between cause and effect can not be proved in any instance. In fact, if we except the example of quack-medicines cited, in all other cases, even the most vivid imagination will fail to cast a bridge—be it ever so frail—over the chasm that separates what has preceded from the *seeming* effect. In short, many prophecies that can be found and met with every day among the people, in newspaper advertisements, etc., are replete with error, and wholly unreliable. It is, then, not surprising that one comes to regard all predictions skeptically; in fact, one is entirely justified in looking upon at least nine tenths of them with suspicion.

The true observer will not rest content with the mere word "experiment," a term so universally used. If one comes to look into matters closely, it will nearly always be found to refer to mere enumeration. Rarely has a word been more misused than this one, "experiment." Science has found a more adequate expression, and terms it "induction." Induction is the means of discovering and proving general propositions. This simple definition should be remembered.

The best-known form of induction is Bacon's method by simple enumeration. Can this method be successfully applied to formulate predictions? Many scholars consider this way of going to work entirely useless for the ascertaining of truths. "Of what use can it be," they say, "to know that a certain phenomenon has taken place a hundred times? Does that afford any guarantee that it *must* take place again? Or, even granting that it may happen once more, can not the time come when it will not occur?"

Hence, induction by simple enumeration does not seem to be adapted to the finding of general truths, such as science demands, and in consequence does not seem serviceable as a means of securing definite predictions. In fact, induction *applied without the necessary caution* is the most crude and deceptive means of arriving at general truths, and gives rise to innumerable false conclusions; and yet we owe to this inadequate method some important empirical generalizations.

In many parts of Europe the saying is common, "A western wind brings rain," and it is undeniable that there is a certain connection between rain-storms and a wind from the west. Occasionally, however, rain will put in an appearance from whatever quarter the wind may be blowing. But, as rain is experienced particularly often during westerly winds, the statement above—"a western wind brings rain"—may, with some slight reserve, be permissible.

Almost every one owns a barometer. If, in the summer-time, some little excursion is planned, the mercury in the tube is watched with anxious eye to see whether it will rise, for this is generally regarded as predicting clear and dry weather, whereas the sinking of the mercury points to rain and storm. Until quite recently the true relation between these phenomena was not known to science, and yet it could be safely assumed that there was, in some way, a connection between them. Thus, Otto von Guericke, the inventor of the air-pump, in the year 1660 correctly predicted a storm from a considerable depression that he observed in the water-column of his immense barometer, which measured nineteen Magdeburg ells in length.

If we look back for a moment on these predictions in the field of natural science, we must admit that they can not lay claim to any great degree of accuracy. In Europe, as well as elsewhere, a westerly wind is often accompanied by fair weather; and sometimes it will rain, although the mercury has risen in the barometer.

Predictions like these may hence be made, but with a certain amount of reserve. Some of them, however, are predictions of a superior order—to be discussed hereafter—as in many of them the accompanying conditions are studied, and hypotheses as to the phenomena observed are formulated and discussed in connection with others. The generalizations considered thus far may only be looked upon as probable; there are, however, instances in which the probability can be more fully depended on, although, in these too, the simple method of enumeration is employed.

A case where the probability of the prediction borders on certainty is found in chemistry in enumerating the properties of chemically pure substances. If we say, "All globules of mercury have a grayish-white color, a metallic luster, are opaque," etc., these are assertions true *without exception* as far as mercury in the perfectly pure state is concerned. If we are dealing with a substance that is chemically pure, we can predict with certainty that it is endowed with certain properties. In fact, we may state it as a natural law that, under all circumstances, substances which have been recognized as identical by the comparison of a series of properties will exhibit other series of like properties. We will call this the law of coexistence of like properties, or, to be brief, the law of coexistence.

The counterpart of this is the law of universal causation. This law, so important a one for predictions, may be thus expressed: under

exactly the same conditions, the same natural phenomena will always take place.

This law is at the present time recognized by all philosophers. There is, however, a dispute as to whether it is true *a priori*, or whether it can only be proved by experience. John Stuart Mill justly insists that the latter is the case. The correctness of this law is rendered evident through simple induction by means of mere enumeration. It was only a clear understanding of this law that brought about exact repetition of scientific experiments, and made possible positive predictions of the phenomena that would follow.

Another class of predictions and generalizations is based on the law of universal causation, or Mill's induction. It was about the middle of the seventeenth century that the fundamental principle of the law of universal causation began to take root among the natural scientists, as the impression gained ground that in nature like conditions necessitate the taking place of like phenomena. Since then, this fundamental principle has gradually come to be general property of all sciences. It has even penetrated into many classes of the people, into the workshop of the mechanic, into the hut of the glass-blower. It is, however, undoubtedly true that with many persons the idea is not clearly brought to consciousness, that thousands of mechanics, miners, etc., act in accordance with it, without being able to express in words what they seem to feel instinctively. If in their work some attempt fails, if the matter turn out differently from what they had expected, nowadays, they will hardly ascribe the failure to some evil spirit who seeks to mock them, but the eyes of the common workman oftentimes will more quickly discover the fault in his appliances and apparatus, than the "evil-eye" of the superintendent.

The essence of Mill's teaching is the empirical deduction of the conception of causes. He has practically evolved this from the law of causation. When an event takes place on a certain combination of conditions, and if this event no longer results when one of these conditions is omitted, then this condition is an *essential* one, a part of the cause. What, then, is the cause of a natural phenomenon? It is the sum of the essential conditions, in consequence upon which the phenomenon invariably follows. Now, it is evident that, if the cause of a natural phenomenon be known, and if this cause occur in any given case, then the effect can be predicted with certainty. This gives us a clearer insight into the *theatrum mundi*, so that in many instances we may know on the rising of the curtain what must come.

If a chemist announces the existence and the properties of a newly discovered substance, for instance, of a new coloring-matter, and we place faith in the accuracy of his work, then we feel convinced that this substance will always be again found whenever the same conditions are brought about, although the induction in this case may be based on only a few observations, or may rest perhaps on a single but

well-observed instance. An experienced photographer knows that his work will be successful, provided he carries out with care certain directions that have proved efficient.

If new gas-works or telephone-stations are to be set up in a town, it is desirable that one proceed in the same manner as has been done in the erecting of the best of similar establishments elsewhere. If this be done, then good gas-light, etc., may be guaranteed.

At this place should also be mentioned the repetition of laboratory experiments on a large scale. In such cases the results attained may astound the lookers-on, especially if nothing of the kind has been previously known, but the originator may calmly await developments after he has once made sure of the result on a small scale. It was but a short time ago that the reefs at Hell-Gate were blasted. This grand act was brought about ultimately by the pressure of a child's finger on an electric knob, and the event took place precisely as had been expected.

Of late the correct application of the law of causation has become of great importance in agricultural chemistry. It is a well-known fact that plants need for their nourishment not only water, warmth, and light, but also a quantity of certain salts contained in the soil. When wood or other vegetable fiber is burned, ashes remain ; these represent the salts that the plant has abstracted from the ground during its life. Bearing this in mind, the ashes of the cereals, of clover, and other plants used for feeding purposes have been examined—the ashes of the seeds as well as of the leaves and stalks.

In connection with these investigations the so-called water-cultures of some plants were undertaken. These consist in raising plants in flasks with water, adding to this, in some cases, certain salts found in the ashes of the plant, and in other cases withholding some of these salts, in order to study their respective influence. In this manner the effect of the different constituents of the ash has been traced, and in this way the means have been found, not only of securing the proper nutriment for the products of the field and the flowers of our gardens, but of raising crops of a desired quality—in fact, of causing crops to grow on soil that would previously not bear at all. An effectual guard has thus been found against exhaustion of the soil and all its consequences.

The examples cited will suffice to show that considerable importance attaches to this class of predictions and generalizations, based on the law of causation. Generally speaking, these are the most reliable predictions that can be made. To what extent these are worth believing in depends, of course, on the amount of care with which the conditions that affect them have been observed, also on the extent to which they may be varied, and on the more or less accurate knowledge possessed as to the effects which are produced by these conditions.

Other predictions and generalizations are based on theories and hy-

potheses. Unfortunately, Mill's induction and the ascertainment of cause by eliminating the non-essential conditions will no longer suffice when the natural phenomena to be examined are too complex, or when several important conditions can not be subjected to observation; this may be owing to various reasons, such as excessive distance, extreme minuteness, insufficient acquaintance with the matter, etc. One has not far to seek for instances of this kind, for a great number of natural phenomena belong wholly or in part to this division. We may here refer to the complex processes which take place in the human system, to many phases of animal and plant life, to the evolution of the crust of our globe, to the problems presented by the starry heavens.

When observation and direct investigation do not suffice for the finding out of the cause, the investigator turns for aid to theory or hypothesis. These differ only in degree, and we will consider them both as theory in a wider sense. Our main interest here centers in the predictions of a theory; these afford the standard by which the value of a theory may be determined—its merits correctly judged. The larger the number of successful predictions under varying conditions, made by means of a theory, the higher will such a theory deservedly rank in our estimation.

In chemistry, the modern theory of the science well serves to illustrate this point; in physical geography, the tides furnish a striking example. It seems remarkable that Pythias already divined a certain relation between the phenomena presented by the tides and the moon. In the middle ages, however, this view of the case was again obscured by wrong hypotheses. The basis for a clearer understanding of the periodical changes of the sea's surface was presented by Kepler in his statement that, if the earth should suddenly cease to attract the waters upon it, these would immediately strive toward the moon. Why the sea should also rise on that side of the globe not facing the moon was satisfactorily explained by Newton. When the dependence of the tides on the combined force of attraction of all the celestial bodies concerned had been established, much still remained to be done in the last century in the way of accounting for and settling fine points and details. In 1740 the Paris Academy presented as subject for a prize essay the problem of a mathematical theory of the tide phenomena; in consequence, such a theory was partly developed by several competitors. But it remained for Laplace to bring mathematical calculation into harmony with the theory, by applying it to the prediction of the actual movements of the waters. Nowadays many calendars, especially those of seaports, state the exact time of the setting in of ebb and flood tide, calculated a year in advance.

The most striking proofs of the coming true of predictions based on theoretical speculation are undoubtedly furnished by astronomy. The views of Ptolemy already permitted a limited series of predictions, but the faults of his system became more and more apparent in

the course of time. A remedy for this was sought in complicated extensions of his teachings; this, however, only made matters so much worse, without explaining the facts. King Alfonso X of Castile is reported to have said to his astronomers that, if the arrangement of the universe had fallen to his lot, he would have made things much more simple. All of these difficulties were suddenly removed by Copernicus. The course of the planets now no longer appeared a cause for great perplexity, but admitted of a simple explanation and resolved itself into one grand harmony. Then, after Kepler had discovered the three laws that bear his name and which mark a new era in the science, the mathematical part of the work was brought to an end by Newton's discovery of the law of gravitation.

Eclipses of the sun and moon always attract general attention. On such occasions it is not only the phenomena themselves that call for our admiration, but mainly the art which makes possible the prediction of these events to the hour, the minute, ay, the second; by means of which one may know in advance whether the eclipse will be total, partial, or annular, what part of the sun or the moon will be first covered, how long the phenomenon will last, and from what parts of the world the eclipse will be visible.

If a prediction rest on a hypothesis prepared *ad hoc*, no matter how ingenious it may be, our doubts and our mistrust are justified. In such a case we have the right to ask for confirmation, and to demand that the hypothesis shall be extended into a theory by its sequence, and that this sequence shall stand in accordance with the actual facts. If, however, a prediction is based on a theory which approaches in thoroughness and in extensive confirmation the cases we have cited as examples, and furthermore, if the separate instance be deduced in a strictly logical manner, then the prediction is worthy of our confidence. As most systematic classifications are of value only in affording a general view of the ground, without being able to embrace all cases, so, too, in our classification, we meet with instances of transition and combination.

Of this, examples are to be found in all the sciences, but notably so in medicine, geology, and meteorology. The predictions in medicine to a great extent form transitions between the first and the second class; that is to say, they are based in part on Bacon's, in part on Mill's system of induction. Thus, of late, the theory of bacteria has come to be of great importance. This theory is of recent origin, but has deservedly many champions, and offers an insight into new ways, which medicine, in combination with natural science, must explore in order to obtain valuable results. Based on these views, which would designate certain bacteria as carriers of certain diseases, new precautionary measures have been adopted, which are to serve as a guard against the phantoms of disease; and in many places these measures have already proved of great value.

The meteorology of to-day is in a state of development similar to that of medicine. Within the recent past, this science too has made wonderful progress, and is rich in promise for the near future. The meteorological predictions prove of great service to the agricultural interests in the United States. The whole system is excellently organized and very extensive; the official publications embrace the "probabilities" and the so-called "weather-maps."

While meteorology is concerned with the rapid changes that take place in the atmosphere, the science of geology is devoted chiefly to the study of the slow changes ever going on in the crust of our globe. If the geological formation of a district be but known in its essential features, a geologist is often able to predict the finding of coal-beds, ore-deposits, etc., basing his prognostication on the occurrence of certain fossils, the order in which the strata are placed, analogous formations in other districts, and so on.

Finally, we must just refer to one class of—shall we say predictions?—that are based on illusions. To cite but one example of this type, Nostradamus predicted that in this year, 1886, the world would come to an end, because Good Friday this year happens on St. George's day, and Easter coincides with St. Mark's day—i. e., the 25th of April, the very latest date on which Easter can happen. At the present time a prophecy of this kind is only commented on as a matter of curiosity, whereas the year 1000, for which the coming-to-an-end of the world had also been predicted, witnessed a general preparation for the event.

SKETCH OF OSWALD HEER.

"IN September last," wrote the Marquis Gaston de Saporta, in July, 1884, "Switzerland, and we might say Europe—so universal was the man's fame—lost in Oswald Heer one of the most fertile of naturalists, one of the most devoted to work, the one to whom the still new science of fossil plants is indebted for its greatest progress. Not only in his own country, but far beyond, as far as explorers have been able to penetrate, from Portugal to the depth of Siberia, from Sumatra to Spitzbergen, from Nebraska to Devonshire, in Saxony, in Austria, in Russia, everywhere, in short, where fossil plants have been discovered during the last thirty years, the name of Oswald Heer has been invariably united with the publication of the plants, the determination of their age, and with the definition of all the circumstances that can aid in identifying them and in attaching a meaning to the several wholes of which they originally constituted a part. Paleontology, geography, the laws that preside over the present distribution of plants and their migrations in times anterior to ours, and the delicate considerations which appertain to the filiation of species, to the order of succession of

floras through the past, the variations of climate, the movements of the crust of the earth, all these subjects, recently hidden, now just brought to light, alike depend on the persevering labors of Oswald Heer, and derive from his researches at least partial elements for their solution." "Nature" remarked, in noticing his death, that "however the study of fossil plants may rank in the time to come, Heer's name will forever be bound up with it as its great pioneer." And Dr. Asa Gray said, on a similar occasion, that his works "make an era in vegetable paleontology. Their crowning general interest is, that they bring the vegetation of the past into direct connection with the present."

Oswald Heer was born at Niederutzwyl, in the Canton of St. Gall, Switzerland, August 1, 1809, and died in Lausanne, September 27, 1883. His father was a clergyman, originally of the Canton Glarus, and came of a family that enjoyed an honorable distinction in Swiss history. Of the three branches of the family tracing their descent from a common ancestor, Councilor Abraham Heer, born in 1580, one was extinguished in the male line in the fifth generation; the second, after having produced a number of honored statesmen, came to a similar end with the death of Federal Councilor and President of the Federation, Dr. Joachim Heer. The third branch, whose sons through five generations have nearly all been clergymen, is the one to which the subject of this sketch belonged, and it still lives in several families.

Oswald Heer was an infant of good physical promise; but before he was a year old he was brought nearly to the grave by scarlet fever, and never recovered from the effects of the attack. He was made weak for the rest of his life, for many years an invalid; but, having inherited a strong constitution, he was nevertheless capable of enduring extraordinary fatigue with great ease. In 1811 Pastor Heer was called to be director of a newly founded high-school for boys at Glarus, where he was guaranteed a position for three years, and eventually remained five years. Thence, in January, 1817, he removed to Matt, in the Kleinthal, where Oswald spent his boyhood. In that deep recess of the mountains, whose only communication with the world at the time was by an arduous bridle-path, the good pastor performed the part of a general dispenser of beneficences. He urged the construction of better roads; there being no doctor at the place, he learned to take care of those who were brought to him with frozen limbs or hurt by avalanches; he introduced inoculation for the small-pox; he taught the workmen in the slate-quarries lessons of temperance and thrift, to save their earnings rather than spend them in the beer-shops where they were paid to them; and he labored hard and with success to supply his people with improved schools.

The tendencies of young Heer's mind began to assert themselves in the earlier stages of his education, which was conducted under the supervision of his father. He kept an exercise-book, in which he reproduced a number of moral and religious stories. Among these sto-

ries was one of the education of the family of a Herr Gutman, a work apparently of a kind with our English "Sandford and Merton," with which the youth was so charmed that, not doubting its reality, he made earnest efforts to become acquainted with the children, sending letters to his friends in other places in hopes that they might be able to forward them to the proper addresses. Pastor Wyss's "Swiss Family Robinson" fell into his hands and awakened in him an intense interest in natural history. He tried, as nearly as circumstances would allow, to repeat the adventures and exploits of the four sprightly youths of this story. He had no buffaloes, and jackals, and ostriches to subdue and train; but he could catch and tame magpies, and hawks, and marmots, and foxes. His experiments were not always fortunate, but he learned. A letter which he wrote to his cousin is interesting as showing how much he admired his "Robinson," and as marking the progress he was making in the study of the ancient languages, by the comical mixture of German and Latin words in which it is composed. Four years later, in 1823, he was beginning fractions, had finished the Latin Grammar, and was interlarding his letters with French phrases. A few months later these gave way to attempts at the Greek characters, and he was learning to draw; for on the 1st of December he wrote, "To-day I finished my head." It is remarked of this period by his brother, Pastor Justus Heer, that he who afterward exhibited such great powers of memory learned his classical vocabularies and inflections only with the greatest labor, and, being chided by his father for his dullness, got up at four o'clock in the morning to give himself more time for the drill. He afterward added Hebrew to his linguistic acquirements, and gave himself object-lessons in mathematics by calculating the areas of familiar objects, taking the levels of the new road, and measuring the heights of the neighboring mountains. "Once upon a time" one of the papers containing some of his calculations was carried away by a gust of wind, and was supposed to be lost; but it was returned a few days afterward by a mountaineer, who said, "Here is a letter that came down from the sky, and must belong to the parsonage."

The enthusiasm awakened in him by the example of the Robinson boys was permanent, and was manifested in the interest he took in everything living. He attended to the milking of the goats, took upon himself the care of the bees and their swarms, and had collections of beetles and butterflies as early as 1822 or 1823. He was anxious to identify and classify his specimens, but on this subject his father could give him but little information and no scientific aid. He became acquainted with choir-director J. J. Blumer, of Glarus, who was the owner of a small collection in natural history and a few scientific books, and borrowed from him, October 4, 1823, Wilhelmi's "Description of Insects." The question now was how to make this treasure his own. His father advised him to copy out the most important parts

of the book; and he wrote out, in five thick manuscript parts, the *Coleoptera*, *Hemiptera*, and *Lepidoptera*, illustrating them with drawings in the margins of copies of the figures in the book. In thankful recognition of the aid which this work gave him, and of the kindness of its owner, he some years afterward named the oldest fossil bird of Switzerland, which he found in the slates of Matt, after the musician, *Protornis Blumeri*. Now he could pursue his collecting with a good heart, and, with the co-operation of his brothers Samuel and Heinrich, he did so; and for many years no beetle, or butterfly, or caterpillar, was safe from their hands.

His attention was at first given wholly to animals, and chiefly to insects; and it was not till June, 1827, that any evidence appears in his diaries of his beginning to take an interest in plants; but from this time on botanical references are frequent. More than a year before this, in January, 1826, he had begun the record of meteorological observations, which he kept up three times a day for two and a half years till the middle of 1828, when he went to the University of Halle. Young Heer was accustomed to make frequent excursions to the mountains, accompanied usually by his father or his brothers. In this way he became acquainted with the entomology and botany of the whole canton, and enlarged his collections and made them objects of attraction. An acquaintance with Georg Spielberg, a botanist, who was conducting a high-school at Mollis, brought him an introduction to the learned Dr. Hegetschweiler, one of the most distinguished men of the confederation in that science; and through these connections, and by means of visits which he made with his father to the leading towns of Switzerland, he brought himself into relations with nearly all the scientific men of the country. Now he offered for sale a herbarium of two hundred and fifty Swiss Alpine plants, duly labeled, with which he hoped to obtain pocket-money for his journey to the university. As the time drew near for him to go there, he became more diligent in study. He assigned a task to every hour of the day, from four o'clock in the morning till seven o'clock in the evening. The most of the time was given to theology and church history. Two hours were allotted to botany, and one hour in the evening to the care of the goats and sheep.

He started for Halle on the 30th of September, 1828, carrying his plant-box filled with bulbs. His purpose was to study theology; but, while he gave due attention to the lectures on philosophy and metaphysics and the canon of Scripture, he formed personal relations with the botanists and entomologists and the specialist in ferns, and the zoölogists whose names may be found in the lists of the faculties of Halle of that time; and, while he still nursed his religious inclinations, he also kept up and cultivated and made to grow the taste for scientific investigation. His vacations gave him opportunities to make excursions of considerable length, which he improved to the increase of

his scientific knowledge. One was upon the invitation of the naturalist Meyer, to Hamburg and Heligoland, where he saw the ocean for the first time; another was to the Harz Mountains. Toward the end of his career at the university, he accepted a call to teach pedagogy and botany at the school of the orphan-house. Fritsche, who was one of his pupils, says of his lectures, "We were of course struck with his foreign dialect, but we also took good notice that he understood his subject." His last excursion from the university was made to Berlin, where he met Ehrenberg the microscopist, Von Chamisso the circumnavigator, and Schlechtendal the famous botanist, who already knew him well by name from Hegetschweiler's mention of him in his "Schweitzer Pflanzen."

Heer left the university in March, 1831, stood his examination in theology at St. Gall in April, preached his first sermon at Wolfhalden, and was ordained on the 10th of June. His father desired him to devote his life to teaching, and to become the head of a high-school which they would found. Heer himself preferred to take a parish, where his work might give him opportunities for continued scientific investigations. Before a decision was reached, his physical condition demanding recreation, he made some important excursions among the mountains, which were quite adventurous for that time. In January, 1832, he accepted an invitation from Herr Heinrich Escher-Zollikofer, of Zürich, to go and arrange his extensive entomological collection. This was the event that decided the course of his life. He became a member of the Physical Society of Zürich, and read before it his first paper, "On the Red Snow of the High Alps." He formed a connection with Julius Froebel, who afterward lectured and conducted German newspapers in the United States, and published with him in 1834 the first number of a geographical magazine—"Mitteilungen aus dem Gebiete der theoretischen Erdkunde"—of which four numbers, in all, were issued.

Heer had not been many months at Zürich when an invitation came to him to take the pastorate of the parish of Schwande. He was already expressing regret in his letters that his attention was being diverted from theology, and he seems to have suffered a painful hesitation between the possible duty of accepting this call and continuing in his scientific work. He submitted the question to Herr Escher, who replied that the field and influence of the scientific investigator, who had the whole world, was much broader than those of the pastor, which were confined to his parish or his canton. Moreover, the naturalist too can work for God's kingdom. There were many pious pastors, but pious naturalists were, according to his present knowledge, a tolerably rare plant, and therefore the more to be prized and the more necessary to the tribe of the learned. With these conflicting views troubling his mind, he was entertaining plans for a scientific journey to India and the Himalaya Mountains, when, in February, 1834, he

was appointed a teacher of physics, botany, and mineralogy, in the High-School of Zürich. In October, 1835, he was appointed Professor Extraordinary of Botany and Entomology, in the same school, and his position and career were fixed for life. He became Professor of Botany in the university when it was founded, in 1852, and in the Polytechnicum in 1855. He founded the Botanic Garden of Zürich, and became its director, and became President of the Society of Agriculture and Horticulture in 1845. For twenty years he was a Rathsherr, or member of the Grand Council of the city. He was elected to the American Academy of Sciences in 1877.

The general character and value of Professor Heer's scientific work are expressed in the commendations passed upon it by the Marquis de Saporta and others, extracts from which are given at the beginning of the present sketch. His scientific publications, according to the list given in the "Botanisches Centralblatt" in 1884, are seventy-seven in number, besides the seven quarto volumes of the "Flora Fossilis Arctica," which comprise a considerable number of independent memoirs. They are in the departments of entomology, botany, and palæo-botany. Following shortly after his first published paper, already mentioned as communicated to the Physical Society of Zürich, were two memoirs published in his geographical magazine, on the geographical distribution of insects and plants in the Swiss Alps, the former paper of which was afterward expanded into a memoir on the Swiss Coleoptera. From this time on his labors were continuous; as M. de Saporta remarks, they touch and are interlinked, and nothing interrupts them. Beginning with the study of insects, as we have seen, he was led naturally to regard flowers, the habitual haunts of insects, and thence to the examination of the fossil insects and plants of Œningen, whence his labors expanded to embrace the fossil flora of the world. His attention was first directed to the tertiary beds of Œningen, by his friend Escher von der Linth. These beds are situated not far from Zürich, on the right bank of the Rhine, near where it issues from the Lake of Constance, and include in a series of thin sheets, like leaves of paper, innumerable impressions of insects and plants. Scheuchzer had found there, nearly a hundred years before, a skeleton which he took to be of one of the victims of the flood, but which Cuvier determined to be a salamander, and later naturalists to be a congener of species now existing in the fresh waters of Japan and in the American lakes. More than six hundred species of plants and a thousand insects have been found in these beds and described by Heer, the chief results of whose labors upon them were published between 1847 and 1853. He devoted three large works to accounts of the ancient flora and the geological past of Switzerland. The first was the "Flora Tertiaria Helvetiæ," which appeared 1855–1859, in three volumes, with one hundred and fifty-six plates; next was the "Urwelt der Schweitz," in 1865, which was translated into six lan-

guages; and the third was the "Flora Fossilis Helvetiæ" in one volume, with seventy plates. He passed the winter of 1854–'55 in Madeira, on account of his health, and on his return from there published a paper on the fossil plants of that island, and another on the probable origin of the existing flora and fauna of the Azores, Madeira, and the Canaries. In this paper, and in a work published in 1860 on tertiary climates in their relation to vegetation, as well as in parts of his larger works on Switzerland, he propounded his theory of the existence of the Continent of Atlantis, during the Miocene period; a theory to which he held steadfastly for many years, but which the later soundings have shown to be extremely improbable in fact, and his own researches to be not needed to account for the phenomena of the distribution of plants and animals over the earth.

In 1862 Heer examined the fossil flora of the lignites of Bovey-Tracy in Devonshire, and published a memoir upon them in the "Philosophical Transactions." At about the same time, he published a paper in the "Journal of the Geological Society" on certain fossil plants of the Isle of Wight. As his fame grew, fossils were sent to him in masses to be examined from all parts of the world; and we find among his papers notes on the cretaceous *phyllites* of Nebraska, the floras of Moletein in Moravia, Ruedlinburg in Germany, the Baltic miocene of Prussia, of the lignites of Zsélythales in Hungary, of Andö in Norway, and "Contributions to the Fossil Flora of Portugal." All of these works, important as they were in themselves, were only leading up to the great work of his life—the investigation of the Arctic fossil flora and the deduction from it of a satisfactory theory of the distribution of life over the earth. According to Dr. Gray, his first essay in this domain—which he has made so peculiarly his own—was in a paper on certain fossil plants of Vancouver Island and British Columbia, published in 1865; and in 1868 he brought out the first of the series of memoirs upon the ancient floras of Arctic America, Greenland, Spitzbergen, Nova Zembla, Arctic and Subarctic Asia, etc., which together make up the seven quarto volumes of the "Flora Fossilis Arctica," the last of which was finished only a few months before his death. According to M. de Saporta, he had been struck with the importance of the American element in what he called the Molassic flora of Switzerland. There was no question in it of vague analogies, but a number of dominant and characteristic species were represented by "homologues" or directly corresponding kinds now peculiar to North America, while there was nothing like them in Europe or the whole Eastern Continent, except as fossils. Among these plants were the sequoia of California, the cypress of Louisiana, the parasol palm of the Antilles, the tulip-tree, maples, and poplars, the European fossil forms of which were as like them as if they had been shaped upon living American trees as models. He saw in these resemblances, which implied that identical species were at some time in

past ages diffused simultaneously through both continents, indications of ancient territorial connections. The substitution of the hypothesis of a common origin of life at the poles and its diffusion by migrations to the southward over all the continents, for the theory of Atlantis, which he had expounded in his earlier works, was of gradual growth, and was the direct result of his examinations of the Arctic fossil flora. In this he was struck by the abundance of the species of a southern and even tropical character, which he found in beds reaching far up toward the extreme north. On the evidence of such fossils was built the theory of a warm, moist climate prevailing in the Arctic as well as in the temperate and sub-tropical regions during the Tertiary period, which, suggested by Heer, has been and elaborated by De Saporta, and is avowed by Dr. Gray.

Heer never accepted the Darwinian theory of the origin of species by variation and natural selection. To it he objected, in general, that no new species had arisen within human knowledge; that no transitional forms had been discovered anywhere; and that it was inconsistent with the progress from simpler to more highly organized beings which he conceived to be the rule of development. To account for the changes that had evidently taken place during geological history, he supposed that, at certain undetermined epochs, species underwent changes, the completion of which occupied only a relatively short time, to be again consolidated and continue unchangeable till the moment when another crisis should bring on a new recasting.

The delicate health which marked his life during the period in which he was best known to science prevented Heer's making extensive explorations in person. Most of his time was spent in his study, examining the collections submitted to him by stronger and more active men, and more capable of enduring the fatigues of such works. But it is to him, M. de Saporta remarks, that we are indebted for our knowledge of the meaning of what such men discovered. Without him, active to his last hour, it would have taken a very long time for phytologists, in the absence of any concert of understanding, to accomplish the summarizing of their aggregate work which he did so successfully, and with so much clearness and intelligence. He was a sufferer from pulmonary disease, and during the last twelve years of his life did much of his work in bed, having his papers and specimens arranged upon a table before him, while his daughter acted as his scribe. Having finished the last volume of his "Fossil Arctic Flora" in the summer of 1883, he was taken to a sheltered retreat on Lake Geneva, for the recovery of his exhausted strength; and he died at his brother's house. It is said of him by his biographer in "Science," and repeated by Dr. Gray, that "a man more lovable, more sympathetic, and a life more laborious and pure, one could scarcely imagine."

EDITOR'S TABLE.

THE CHURCH AND STATE EDUCATION.

THERE are some good things that seem just a little too good for many of those who profess to prize them most highly. One of these, we regret to say, is religious liberty. If there is any one thing that the people of this country, taken in the mass, are bent on preserving and enjoying, it is this; and yet it is this very thing that some excellent people, who are far from regarding themselves as abettors of spiritual tyranny, are continually seeking to undermine. Our excellent contemporary, the "Journal of Education," of Boston and Chicago, has lately called attention to the action of the Presbyterian Synod of the State of New York, in referring to a committee, to be reported on at the next annual meeting, a resolution affirming that, while a union of church and state in this country is not to be thought of, it would still be desirable to incorporate into "the course of State and national education" certain very specific theological doctrines, in which, as it was stated, all Christian sects agreed. These were: the existence of a personal God, the responsibility of man to God, the immortality of the soul, and a future state of rewards and punishments. We can not suppose for one moment that those who favored this resolution would wish such doctrines as these to become topics of discussion in the public schools, or to be treated as in any way open to doubt or as subject to possible future rectification. If taught at all, they would have to be taught on authority, just as the catechism might be taught in church schools. This being the case, we can not understand how the members of the synod who favored the resolution could help seeing how vain was their disclaimer of any desire to establish a connection between church and state. The whole essence of an ecclesiastical establishment consists in the assumption by the State of the right to guide individual citizens in the formation of theological opinions. It matters not how many or how few those opinions may be, how much or how little of theological subtilty their formulation may involve; whenever and wherever the State looks upon the individual as unfit to guide himself in such matters, and therefore undertakes to teach him dogmatically what he ought to believe, then and there we have the elements of ecclesiastical government.

Now, the instinct of the American people has hitherto been that theology and religion do better without the patronage of the State than with it, and that it is not safe to intrust the civil power, whether Federal or local, with the making of any law looking either to the establishment of a church or to the encouragement of any special form of religious belief. We choose our own rulers and we set them over us, not in spiritual matters, but in temporal only, and, if we are wise, we shall restrict their action even in the temporal sphere as much as possible. This by the way: What is perfectly clear is that our people do not want to receive direction in theological questions at the hands of the State, and therefore are not prepared to have theology—even its most widely accepted propositions—introduced into public-school teaching. It is felt that the State has no business to *make* opinion in these matters, which it undoubtedly would do if it were allowed to impart any theological instruction whatever. Let, for example, the propositions above mentioned become a part of public-school teaching throughout the length and breadth of the land, and the modification of opinion to which

this would lead would tend to prepare the way for the introduction of more specific theological teaching, and, little by little, we should have, by the help of the State, a kind of official theology formed, the influence of which on the development of thought, and perhaps also of morals, would be far from favorable. No better way of stereotyping a civilization could be devised than for a government, through the public schools, to undertake to tell people what they should believe on the most fundamental questions of theology and philosophy.

We should therefore strongly advise all well-meaning people to pause before they give their support to measures which certainly would not have the beneficial results which we may be sure they have at heart. In what we have said above we have assumed the success of the supposed attempt of the State to control the theological opinions of the people. But there is a possibility that things might take a different turn, and that State patronage of certain forms of opinion might tend to produce skepticism in regard to the very doctrines it was sought to protect and strengthen. We hold very strongly, for our own part, that in the public schools, controlled as they are by the civil authorities, nothing should be taught beyond the broad and demonstrable results of human inquiry. We may perhaps trust our politicians, through their nominees, to give our children *facts;* because, if they depart from facts when they are purporting to give them, it is comparatively easy to bring them to book. It is a different thing, however, to intrust them with the enunciation of theories, particularly in the region of theology. If they go wrong there, who is to check them? What standard is to be applied? If they teach in a dull, formal, mechanical way what, if taught at all, should be taught with earnestness and conviction, how are we to repair the mischief they will certainly do?

There is, lastly, a point to consider, which our contemporary, above referred to, urges with a great deal of force—the question of simple justice. It is known that, whether or not all Christian sects are agreed in accepting the theological propositions set forth, the whole community does not accept them. It may be unfortunate that it should be so—we do not discuss that question—the fact is that it *is* so; and people who want a merely secular education for their children would have reason to complain if a teaching they did not think best for their children's minds should be forced upon them. The State, be it remembered, has completely dwarfed and starved out private enterprise in education, so that the average parent has no choice but to send his children to the public school. Should, then, anything be taught there which presupposes a uniformity of opinion that does not exist? If the reason why we have no state church in this land is that we could not have one without doing injustice to some element or elements of the population, the same objection precisely will apply to having an authoritative teaching in the schools of matters that every man claims the right to judge of for himself, and in regard to which important differences of opinion prevail. The case is very simple and clear—too clear to admit of much mystification in the popular mind; and it is to the good sense of the people at large that we trust for the decisive overthrow of any measures looking to the perversion of our school system by making it an agency for the propagation of an official theology.

We invite attention to the opening article in the present number of the "Monthly," which is on a subject of great economical importance. The author, Mr. P. H. Dudley, is an engineer who has given much time and attention to special investigations of the decay of wood and its causes, and presents some

interesting and valuable facts respecting it. As will be noticed by the careful reader, he speaks of what he has himself observed, and much of what he says will be new to all but experts, as it has only recently been recognized by science. His observations establish the fact that most of the decay of wood, including what was formerly called *eremacausis* or slow combustion and dry rot—the name now representing the result, whereas it was formerly held to describe the cause—is produced by the growth of mycelia of fungi, which effect the disorganization of the wood-cells. The figure on page 438, which is from a photograph, tells more on this subject than many pages of letter-press could do. Some of the fungi described and figured by Mr. Dudley are old acquaintances to frequenters of the woods who have observed the curious forms of their *pilei* on stumps and logs, and have supposed them to be fruits of rottenness. Mr. Dudley exhibits the more essential parts of these fungi, the mycelia penetrating and interpenetrating every part of the interior of the wood, and generating the rottenness of which the *pilei* are the sign. Some suggestive observations may also be found in the article concerning the relations of moisture to the growth of fungi. Mr. Dudley will continue the subject in another article, with some practical suggestions founded on the results of his investigations.

We print in this number of the "Monthly" the last of the series of papers by Mr. David A. Wells upon the economic condition of Mexico. Accurate information of a country with which we must inevitably come into intimate political and financial relations is in the highest degree desirable, but has heretofore been very difficult to obtain. Mr. Wells—whose competency to perform the task he has undertaken will be questioned by no one—has done a valuable service, making us acquainted with the actual condition of this but little-known country. As he says, the pictures usually drawn of the natural resources of the country and its future possibilities have been rose-colored in the extreme. He finds, on the contrary, that the country is almost hopelessly poverty-stricken—to such an extent, indeed, that the problem of a stable government is beset with the greatest difficulties. With an army consuming a third of the revenue of the state, a system of internal tariffs between each of the States, or political divisions composing the republic, and with an almost entire absence, until very recently, of means of communication between different parts of the country, anything like industrial progress or political stability has been out of the question. His study of the country does not lead him to any very hopeful prediction of its future. Its natural conformation—that of a great table-land, devoid of navigable streams, with a strip of coast-land on either side which can only be reached by abrupt descents—is unfavorable to the material development of the country; while the character of the people, their extreme poverty, and the enormous load of public debt, are almost insurmountable obstacles to any great degree of prosperity. In our own interest, as well as that of Mexico, he bespeaks a kindly and helpful attitude on the part of this country toward the weaker republic, and his words are well worthy the attention of all Americans who desire to see their country without reproach in all its international relations.

LITERARY NOTICES.

TEACHER'S HAND-BOOK OF PSYCHOLOGY. By JAMES SULLY, M. A. New York: D. Appleton & Co. 1886. Pp. 414. Price, $1.50.

In the present work Mr. Sully has attempted to reduce and simplify the statement of scientific principles contained in his former and larger work, "The Outlines of Psychology," and to expand their prac-

tical applications to the art of education, with the view of "satisfying an increasingly felt want among teachers, viz., of an exposition of the elements of mental science in their bearing on the work of training and developing the minds of the young." Hence, in this particular volume we have a contribution rather to the science of education than to that of psychology. The larger work, though not by any means destitute of educational applications, is to be looked to primarily for the author's views upon the theoretical aspects of mental science. The aim of the newer book is practical. It is to be classed in the same category, for example, with Bain's "Education as a Science," though quite a different work from the latter in plan and execution. Mr. Sully condenses the principles of mental science, and shows what bearing those principles and the facts of which they are generalizations have upon the teacher's art. As its name imports, it is written not for the pupil chiefly, but for the instructor, or the student of educational methods.

Mr. Sully can hardly lay claim to the rank of a discoverer of new psychological truths. This, certainly, is no disadvantage to the success of a work like the "Teacher's Hand-Book." What is wanted is, the ascertained and accepted, so that the teacher may know what science, as knowledge verified, declares about the mind and its operations. This want the author has evidently understood, for he has been successful in keeping within the bounds of legitimate science. Very little exception can be taken to his statements of psychological facts and principles. He is never dogmatic at disputed points, he has no metaphysical hobby which he is bent upon riding, indulges in no polemical discussions, but proceeds in a direct, simple, and effective manner to work out what he tells us in his preface are the objects of his book. No better proof, for instance, of the good sense of the writer can be adduced than the fact that, in treating of volition, there is actually no mention made of the controversies over the "freedom of the will." That expression, indeed, does not occur, nor does "free-will" in any metaphysical sense. We are sure the hackneyed dispute will never be missed, but the self-restraint indicated by this omission is as remarkable as it is praiseworthy.

We are not always quite satisfied, however, with the author's psychological enunciations. For illustration, we will mention his statements about association: he makes out plainly enough in his larger work that there are not three distinct modes of association, but that they can be reduced to one; and yet, with too much caution he sets forth in the "Hand-Book" three, *contiguity*, *similarity*, and *contrast*, because it is "usual" to do so. This is not a sufficient reason, especially when *contrast* has been clearly shown not to be an independent principle of association for as long a time as Professor Bain's "Senses and Intellect" and Herbert Spencer's "Principles of Psychology" have been published. Besides, to retain this as a mode of association is misleading. We do not associate by difference but by likenesses. Association is a process of integration. It is always and essentially what its name imports — assimilation. Representation, a differentiating power, brings up past experiences which association integrates and redintegrates with each other and with presentative experiences. The latter process is the assimilation of contiguities, a segregation and unification of similarities in experience. We think Mr. Sully might advantageously have elucidated in this manner the true nature of association and its connection with the general laws of evolution, since the notes he makes in the "Outlines of Psychology" show that he is alive to the objections that have been raised to the mode of statement he adopts. In fact, he allows their force. Why, then, retain what he does not believe in, merely because it is "usual"? We all concede that errors are common, but can not, therefore, argue that they should be persisted in.

We are inclined to charge our author also with an occasional sin of omission. We are surprised to find that he says so little about belief, for instance, since he has made the nature of that mental state or act a special study, as appears in one of his earlier works, "Sensation and Intuition," and also in the "Outlines of Psychology." In the "Hand-Book," however, there is little more than a passing allusion, in connection with the subject of doubt. The term *belief* is so universally employed in common and scientific use to indicate a certain mental attitude, or certain mental operations,

that, in a work of the character of the one before us, we think something more should have been said to show exactly what this attitude is, and to exhibit more fully the nature of the operations of our minds in *believing* or *disbelieving* anything. We consider that here Mr. Sully has carried condensation too far.

But as the main purpose of our author's work is in its educational applications, so in these lies its chief merit. There is a great deal of interesting observation about the development of the child's mind—as regarding imagination and reasoning, for example; and there are many fruitful suggestions respecting the proper methods to be adopted in promoting the growth of the mental powers and strengthening them. The whole subject of control of the emotions and their various uses is admirably handled. The pleasures of knowledge, the development of æsthetic taste, the erection, maintenance, and following of moral standards—all receive ample illustration with many precepts of practical value. We are glad to see the uses of obedience in childhood, as a means to self-control and to a well-balanced character, so correctly stated. We are very apt to find either the contention that there should be little exercise of authority on the one hand, or on the other that authority should still be controlling as an end in itself throughout adult life. The former idea leads to anarchy, the latter to despotism. This is what Mr. Sully says: "As already pointed out, an indispensable step in the formation of a sense of duty is the assertion and exercise of authority over the child, the making him feel that there is a higher will over his which he has to obey.

"It may safely be contended that obedience in the sense already defined is in itself a moral habit—forming, indeed, one chief virtue of childhood. . . . Nevertheless, it is a common and fatal error to regard obedience to personal authority as an end in itself. The ingredient in childish obedience which constitutes it a moral exercise is the dim apprehension of the reasonableness and moral obligatoriness of what is laid down. And the ultimate end of moral discipline is to strengthen this feeling, and to transfer the sentiment of submission from a person to a law which that person represents and embodies. . . . Commands are a scaffolding which performs a necessary temporary function in the building up of a self-sufficient habit of right conduct" (pp. 393, 394). This is very sensible and wholesome doctrine.

Altogether, Mr. Sully has produced an excellent book, of unique character in psychological works. There is no doubt that it supplies a genuine, not a fanciful need, nor is there any question of the scholarship of the author, or of his fitness to point out practical methods in education. He is himself an educator, and has the experience of the teacher in addition to the accumulations in knowledge of one who has made of the subject of psychology a life-long study. He has done his work so successfully that our thanks and our praise are very cordially, and, as we believe, deservedly, bestowed.

TRIUMPHANT DEMOCRACY: OR, FIFTY YEARS' MARCH OF THE REPUBLIC. By ANDREW CARNEGIE. New York: Charles Scribner's Sons. 1886. Pp. 509. Price, $2.50.

MR. CARNEGIE has produced a very readable book, and one of which an American has reason to be proud as the tribute of one of her adopted citizens. The title suggests a panegyric, and the text does not belie it. The unparalleled material progress of the republic is recounted in the most exultant strain, and its political institutions are given unstinted praise. In comparison with those of the mother-country he finds the advantages all with us, and earnestly hopes that it will not be long before England will be remodeled upon our basis. The magic which has transformed a continent and given the world the strongest and wealthiest of nations he finds in the political equality of the citizens, and this is the thing he deems needful for England if she is to keep abreast of her young and powerful rival. He writes in no spirit of antagonism to England in recounting the triumphs of the English-speaking people upon this side of the Atlantic, but only wishes for her a future as pleasing. The relation of mother and child is the one he continuously holds up, and the drawing closer together of all English-speaking communities expresses his most ardent wish.

The volume would have unquestionably gained in value had Mr. Carnegie written in a more critical spirit, but it is perhaps just

as well that we should have, once in a while, as ardent an admirer and as firm a believer in our political faith as Mr. Carnegie, to recall us to a contemplation of our virtues. Of critics there will always be enough. The following summary of the results achieved by the republic during the first century of its existence well indicates the general tone of the volume:

"1. The majority of the English-speaking race under one republican flag, at peace.

"2. The nation which is pledged by act of both parties to offer amicable arbitration for the settlement of international disputes.

"3. The nation which contains the smallest proportion of illiterates, the largest proportion of those who read and write.

"4. The nation which spends least on war and most upon education; which has the smallest army and navy, in proportion to its population and wealth, of any maritime power in the world.

"5. The nation which provides most generously during their lives for every soldier and sailor injured in its cause, and for their widows and orphans.

"6. The nation in which the rights of the minority and of property are most secure.

"7. The nation whose flag, wherever it floats over sea and land, is the symbol and guarantor of the equality of the citizen.

"8. The nation in whose Constitution no man suggests improvement; whose laws as they stand are satisfactory to all citizens.

"9. The nation which has the ideal second chamber, the most august assembly in the world—the American Senate.

"10. The nation whose Supreme Court is the envy of the ex-prime minister of the parent-land.

"11. The nation whose Constitution is 'the most perfect piece of work ever struck off at one time by the mind and purpose of man,' according to the present prime minister of the parent-land.

"12. The nation most profoundly conservative of what is good, yet based upon the political equality of the citizen.

"13. The wealthiest nation in the world.

"14. The nation first in public credit and in payment of debt.

"15. The greatest agricultural nation in the world.

"16. The greatest manufacturing nation in the world.

"17. The greatest mining nation in the world."

CALIFORNIA, FROM THE CONQUEST IN 1846 TO THE SECOND VIGILANCE COMMITTEE IN SAN FRANCISCO. By JOSIAH ROYCE. Boston and New York: Houghton, Mifflin, & Co. Pp. 513, with Map. Price, $1.25.

THIS history belongs to the "American Commonwealths" series, of which Mr. Horace E. Scudder is the editor, and is presented as a study of American character. That character, earnest, practical, and always self-possessed, is strikingly exemplified in the manner in which a prosperous and advancing State has been organized out of the chaos that prevailed during the earlier years of the California settlement. In studying the subject, the social condition has been throughout of more interest to the author "than the individual men, and the men themselves of more interest than their fortunes, while the purpose to study the national character has never been lost sight of. Through all the complex facts that are here set down in their somewhat confused order, I have felt running the one thread of the process whereby a new and great community first came to a true consciousness of itself. The story begins with the seemingly accidental doings of detached but in the sequel vastly influential individuals, and ends just where the individual ceases to have any great historical significance for California life, and where the community begins to be what it ought to be, viz., all-important as against individual doings and interests."

FOOD MATERIALS AND THEIR ADULTERATIONS. By ELLEN H. RICHARDS, Instructor in Sanitary Chemistry in the Massachusetts Institute of Technology, author of "Chemistry of Cooking and Cleaning." Boston: Estes & Lauriat. 1886.

THIS work is the result of ten years' experience in laboratory examination of food materials, along with careful attention to the literature of the subject, both at home and abroad. It makes no claim to originality, but is intended to give useful information in a form adapted to schools and the home — that is, without technicalities or

unnecessary details. Chapter I is an earnest plea for the education of girls in this vital subject of the quality of food; II considers water, tea, coffee, and cocoa; III, cereal foods; IV, milk, butter, and cheese; V, sugar; VI, canned fruits and meats; VII, condiments; VIII, perishable foods and the means for preserving them; IX, other materials used in cooking; X, principles of diet. Mrs. Richards regards scientific housekeeping as "the duty of the rich and the salvation of the poor." She tells of a young woman who lived and flourished "on corn-meal, cooked in various ways, for a whole year, with only a dinner every Sunday at a friend's house. She kept well and hearty on a peck of Indian-meal a month; so that her whole living cost only about ten dollars a year, as she prepared it herself." Twenty hours a week spent in making pies, cakes, and puddings, at a cost of five dollars, when an equivalent in fruit for dessert can be had for three dollars, with fuel and service saved as well as time, is given as one of the instances of thoughtless waste in which current household management abounds. The excellent works put forth by Mrs. Richards and her example of a life devoted to high practical ends must help on the time when housekeepers will respect their calling, become intelligent and interested in it, and then we may hope that their best thought will be devoted to its improvement.

BULLETIN OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY, Granville, Ohio. Edited by Professor C. L. HERRICK. Pp. 136, with Plates and Tables. Price, $1.25.

THE editor, assuming that every well-conducted institution of learning should form a recognized center of scientific activity, the "Bulletin" is intended to represent the life of the college in its scientific departments. It contains papers, most of them well and clearly illustrated, on the "Osteology of the Evening Grossbeak"; "Metamorphoses of Phyllopod Crustacea"; "Superposed Buds"; "Limicole, or Mud-living Crustacea"; "Rotifers of America, with Descriptions of a New Genus and Several New Species"; "The Clinton Group of Ohio, with Descriptions of New Species"; "A Compend of Laboratory Manipulation," presenting in concise form the methods which have proved to be of greatest service; a condensed translation of Eugene Hussak's tables for the determination of rock-forming minerals; and a brief account of the natural history department of the university.

FOOD CONSUMPTION. By CARROLL D. WRIGHT. —CHEMICAL ANALYSIS AND TREATMENT. By Professor W. O. ATWATER. Boston: Wright and Potter Printing Company. Pp. 90.

THIS is the part of the report of the Massachusetts Bureau of Statistics that relates to the quantities, costs, and nutrients of food materials. The investigation to which it relates was undertaken in the conviction that much money is wasted in the purchase of food that is lacking in the elements of nutrition, and that the incomes of working-men might be made far more effective if their food were provided in accordance with the results of scientific research. To aid in determining this point, a number of schedules of dietaries, giving qualities and costs of food of people of limited incomes were collected, and the constituents subjected to analysis. The results of the analyses are here presented in a comparative form, as between the constituents themselves, and as compared with other dietaries and recognized standards.

HAND-BOOK OF PLANT DISSECTION. By J. C. ARTHUR, M. Sc., Botanist to the New York Agricultural Experiment-Station; CHARLES R. BARNES, Professor of Botany in Purdue University; and JOHN M. COULTER, Ph. D., Professor of Botany in Wabash College, Editors of the "Botanical Gazette." New York: Henry Holt & Co. 1866.

BY the method of this book, plants are first subjected to "gross anatomy," as it is called, or observation, with the aid only of a hand-lens; and then, passing to "minute anatomy," every part is subjected to the compound microscope. The apparatus, reagents, and materials required, have been made as few as possible, and the directions for their use are so clear and intelligible, that they must have been derived from actual and extended experience in giving this form of instruction. The subjects selected for study are common plants, to be found

everywhere, from the green slime on the north side of old fences and the trunks of trees, to the higher or flowering plants. Each one of these examples is studied closely and critically in all its parts. Explicit directions are given, but the student is warned against depending on the manual rather than working out results of his own. By this thorough study of a few examples, the main features of plant-anatomy are made familiar, at the same time that habits of independent observation and judgment are being established. Every school where botany is studied should have provision for getting such a first-hand knowledge of plant-anatomy as is contemplated in this excellent manual. The necessary outfit for such a course of study is carefully stated, but we find no reference to its probable cost—a very practical question, that will doubtless arise in the minds of many persons who are interested in educational progress.

PROTECTION OR FREE TRADE. An Examination of the Tariff Question, with Especial Regard to the Interests of Labor. By HENRY GEORGE. New York: Henry George & Co. 1886. Pp. 356. Price, $1.50.

THIS is a discussion of the tariff question from Mr. George's well-known point of view, that nothing short of the abolition of private property in land can greatly benefit the laboring classes. The author traverses the ground usually gone over in economic works in the consideration of this subject, but by his fresh and vigorous treatment he lends an interest to it not usually found in such discussions. He arrives at the same conclusions in regard to the futility of tariffs to benefit industry as does every competent economist who has investigated the question, but, unlike most advocates of free trade, in current discussions, does not believe in the step-by-step process of reaching the end in view.

"Tariff for revenue only," he contends, is about the most cumbrous and costly method of raising a revenue and is indefensible on economical as well as political grounds. He therefore advocates immediate and unqualified free trade, and in doing so feels assured that the change would not involve the country in any great industrial convulsion. Even if it should, he holds that it is far better for the laboring classes that this should be short and sharp, than that it should extend over a long period, in which there would be time to shift almost if not the whole burden upon their shoulders.

Mr. George does not rest his discussion with the presentation of the generally accepted free-trade arguments, and from his point of view he could not logically stop short of the length to which he has carried it. Protection to the wage-earning class is the professed object of the tariff, and that given to the employer is only a means to this end. It was therefore incumbent upon Mr. George to consider the extent to which free trade can benefit the working-man under present industrial conditions, and to show further what the conditions of industry must be which would give it the greatest value for him. In taking up this portion of his subject he considers the cause of the hold protection still retains upon the industrial nations of the world after fifty years of discussion, and finds it in the belief that protection "makes work," and that this is just what the laboring-man wants. Under the changed industrial conditions he proposes he believes the distribution of wealth would be so changed in favor of the laboring classes that the problem of getting work would cease to be of serious import, and the working-man would then see clearly the essential viciousness of trade restrictions. He closes the volume with an appeal to the working-classes to push the free-trade issue into politics, and sees in its triumph the entering wedge which shall pave the way for his special reform.

FIRST ANNUAL REPORT OF THE COMMISSIONER OF LABOR. By CARROLL D. WRIGHT.—INDUSTRIAL DEPRESSIONS. Washington: Government Printing-Office. Pp. 485.

THE Bureau of Labor was established by act of Congress of June 27, 1884, and the Commissioner was appointed in January, 1885. The Commissioner projected for the first year's work of the Bureau the collection of information relative to industrial depressions, by means of investigations which should comprehend a study of the character and alleged causes of the present crisis, whether the causes were contempo-

raneous in the great producing countries, and whether, as to duration, severity, and periodicity, they had been similar in such countries. The outline also comprehended the collection of data relating to the variation of wages in different countries and in different parts of this country, variations in the cost of living in the same localities, and in the cost of production, with all such alleged causes of industrial depressions as might offer opportunity for illustration through classified facts, and the suggestion of remedies for depressions. Five agents were employed in the investigation in foreign countries—Great Britain, France, Belgium, Germany, Switzerland, and Italy—and fifteen in this country. The results of their inquiries are given in detail, and summarized in this report.

SOCIALISM AND CHRISTIANITY. By A. J. F. BEHRENDS, D. D. New York: Baker & Taylor. Pp. 308. Price, $1.50.

DR. BEHRENDS was invited by the Trustees of the Hartford Theological Seminary to deliver a course of lectures before the students of that institution on the "Social Problems of our Time." This book is the fruit of his studies on the subject, in which he spent a year. In the constructive part of his work, he claims that he has been careful to maintain an independent position. "I have copied from no one, and have frequently found myself in agreement and at variance with the most opposite schools of thought. The method of criticism was fixed for me in my conception of Christianity, and in my settled conviction of its adequacy to solve the pending social problem." In the successive chapters are considered social theories and their history, the assumptions and economic fallacies of modern socialism, the rights of labor, the responsibilities of wealth, the personal and social causes of pauperism, its historical causes and its cure, the treatment of the criminal classes, and "Modern Socialism, Religion, and the Family." The last-named, the closing chapter, is marked by an extended discussion of the true doctrine of the family, which "grew out of the deepening conviction that, in all radical and permanent social reform, a high view of the sanctity of marriage must lead the way."

POLITICAL SCIENCE QUARTERLY. Edited by the Faculty of Political Science of Columbia College. March, 1866. Boston: Ginn & Co. Pp. 152. Price, $3 a year; 75 cents a single number.

THE "Political Science Quarterly" is intended to furnish a field for the discussion of political, economic, and legal questions—the latter heading embracing chiefly questions of constitutional, administrative, and international law, from the scientific point of view, and by a scientific method. Such topics will be preferred as are of present interest in the United States, but no topics will be excluded which can throw light upon the problems and tendencies of our own country. The present number contains an introductory article on "The Domain of Political Science," by Professor Munroe Smith; "The American Commonwealth," by Professor John W. Burgess; "Collection of Duties," by Frank J. Goodnow; "American Labor Statistics," by Professor Richmond M. Smith; "Legislative Inquests," by Frederick W. Whitridge; "The Berlin Conference," by Daniel De Leon; and reviews of new books.

PERSIA: THE LAND OF THE IMAMS. By JAMES BASSETT. New York; Charles Scribner's Sons. Pp. 343. Price, $1.50.

THE author is a missionary of the Presbyterian Board of Missions, and gives in this work a narrative of travel and residence during fourteen years, or from 1871 to 1885. In the first eleven of the sixteen chapters of the book, he gives narratives of extended tours, and such information as seemed to him to be profitable and interesting. The itineraries include the journey from Constantinople to Persia by way of Trebizond and Erzeroum, and to Oroomiah, with accounts of the Nestorians; from Oroomiah to Teheran, with a description of that city; a journey to Ispahan; from Teheran to the Black Sea and back; and from Teheran to Mashhad. In the remaining chapters is given a general review of Persian affairs, including facts which the author obtained in his travels, chiefly from his own observations. They relate to the general account of the country and its social and economical condition, its government, the prevailing religions, and the condition and prospects of missionary work there. Concerning the

value of our diplomatic representation there under Mr. Benjamin, we are informed that "it could not be otherwise than that the arrival (in June, 1883) at the capital of a legation of the United States should create in the mind of the Shah and of the officers of the Persian Government a greater interest in America and Americans. The missionaries were in a position to reap the benefits of this interest, and the minister, in the brief period of his residence in Teheran, was able to secure for them, from the Persians, some valuable concessions."

OUTLINES OF GEOLOGY. An Introduction to the Science for Junior Students and General Readers. By JAMES GEIKIE, LL. D., F. R. S. Illustrated. London: E. Stanford. Pp. 424.

IN this work, as in the "Class-Book of Geology," by Archibald Geikie, noticed elsewhere in these pages, the plan pursued has been first to thoroughly acquaint the student with the various agents that effect geological changes, and their modes of action, and only then to pass on to the study of the different geological systems. The first half of the book is given to a careful investigation of the work performed by the different forces of Nature. This is discussed under two heads, viz.: "I. Epigene, or Superficial Action"; and, "II. Hypogene, or Plutonic Action."

The first of these divisions treats of the action of the atmosphere, of water, and of plants and animals, while the second studies the action of the subterranean forces.

The work done by terrestrial waters in effecting important changes receives due attention; rain, underground water, brooks and rivers, lakes, each is considered at length. Two chapters are devoted to the geological action of ice; another to the influence of the sea.

A review of the part performed by plants and animals in geological changes is followed by a chapter on the classification of the products of surface-action.

The second division, given to the consideration of subterranean action, embraces the subjects of volcanoes and volcanic products; the mineralogical composition of vitreous and crystalline igneous rocks; their petrological character; movements of the earth's crust; the structure of rock-masses; ore-deposits, etc.

A chapter on paleontological geology forms the introduction to historical geology. The divisions here made are four in number: the primary or palæozoic, the secondary or mesozoic, the tertiary or cainozoic, and the quaternary or post-tertiary. Each of these is studied in turn. Numerous illustrations are given of the fossils occurring in and characteristic of the different periods. In fact, these illustrations, together with some others, inserted in the first part of the book, constitute one of the great attractions of this volume.

CLASS-BOOK OF GEOLOGY. By ARCHIBALD GEIKIE, LL. D., F. R. S. Illustrated. London: Macmillan & Co. Pp. 516. Price, $2.60.

THIS volume is intended to complete a series of educational works on physical geography and geology, projected by the author a number of years ago. It is a book written by the light of experience gained in practical teaching, and the writer's aim has been to produce a work that should awaken an interest in and love for the science of which it treats, and thus incite to original study and research.

The book is divided into four parts, and embraces a consideration of the materials for the history of the earth, a study of rocks, and how they tell the history of the earth, an account of the crust of the globe, and a careful analysis of the geological record of the history of the earth.

The influence of the atmosphere in changes affecting the surface of the earth, and the effects produced by water, under various conditions, take up the first few chapters. These are followed by an essay on "ice-records"—a history of the glacial epoch—and then comes an interesting description of how plants and animals inscribe their records in geological history.

In discussing the more important elements and minerals of the earth's crust, brief reference is made to the mode of occurrence, formation, and properties of each, and the crystalline form and the origin of crystallized minerals are carefully studied. Under the head of "The more important Rocks and Rock Structures" is

considered the question of how minerals are combined and distributed so as to build up the earth's crust; attention is here especially directed to the knowledge of rock-structure gained within recent years by the use of the microscope.

Part III treats in turn of the sedimentary and the eruptive rocks. Of the former, the original structure, the association of strata, the chronological value of strata, etc., . . . are reviewed; in connection with the latter, the formation of mineral veins —by deposition from the molten state and by deposition from water-solution—is described.

Fossils, which may be termed "the labels of the strata," receive the share of attention due their importance, and are studied as indicating former changes in geography, former conditions of climate, and the chronological sequence of geological formations.

The rest of the book is given to the study of the main divisions of the geological record—that is to say, to a systematic review of the stratified formations of the earth's crust.

An appendix, furnishing an outline of the classification of the vegetable and the animal kingdom will prove convenient for reference, and the many illustrations embodied in the text of the volume will be a welcome aid to the student.

THE WEALTH OF HOUSEHOLDS. By J. T. DAWSON. Oxford (England): At the Clarendon Press. Pp. 368.

THIS is essentially a book on political economy, the substance of which was first put together, more than twenty years ago, by way of using the experience of a man of business in the education of his children. It was afterward recast and delivered as lectures, and then printed. Having become out of print, it has been entirely rewritten, as a text-book—and with especial reference to some of the economic questions of the day. The principles of the subject, in its several departments, are presented in brief, pointed paragraphs, which are often short enough to be maxims. Considering the situation of workmen, the author deplores subjection alike to capital and to the trades-union; and advises workmen to try to make themselves independent by getting a year's subsistence ahead. This is not beyond their means, for thousands of the class are daily paying the price of it from means drawn wholly from weekly wages.

MANUAL TRAINING. The Solution of Social and Industrial Problems. By CHARLES H. HORN. Illustrated. New York: Harper & Brothers. 1886.

THE contents of this volume are briefly summarized by the author as consisting, first, of a detailed description of the various laboratory class processes from the first lesson to the last in the three years' course of study at the Chicago Manual Training School. The second division is "an exhaustive argument *a posteriori* and *a fortiori* in support of the proposition that tool-practice is highly promotive of intellectual growth, and in a still greater degree of the up-building of character." The third division deals with the history of civilization as related to methods of education, and in the fourth part the history of manual training as an educational force is briefly presented.

COLOR STUDIES. By THOMAS A. JANVIER. New York: Charles Scribner's Sons. Pp. 227.

A BOOK of stories of artist-life, to which an allegorical air is given by the characters bearing the name of artists' colors. According to its motto, the book is without moral or purpose, but "whichever way you look" in it, "you'll only find—a pair of lovers."

A POPULAR HISTORY OF ASTRONOMY DURING THE NINETEENTH CENTURY. By AGNES M. CLERKE. New York: Macmillan & Co. 1886. Pp. 468. Price, $4.

"THE present volume does not profess to be a complete or exhaustive history of astronomy during the period covered by it. Its design is to present a view of the progress of celestial science on its most characteristic side since the time of Herschel." These words, taken from the preface, clearly present the scope and aim of the book before us.

The introduction refers briefly to the three kinds of astronomy distinguished. The first of these is known as observational or practical, the second is called gravita-

tional or theoretical, and was founded by Newton; and the third is best described by the term physical and descriptive astronomy. A short sketch is given of the progress of the science during the eighteenth century, and the rapid advance during the nineteenth century is broadly outlined.

The book is divided into two parts. The first of these treats of the progress of astronomy during the first half of the nineteenth century, the second is devoted to the progress made in recent years. The chapters in Part I embrace the foundation of sidereal astronomy, progress of sidereal astronomy, progress of knowledge regarding the sun, planetary discoveries, comets, and instrumental advances.

Part II discusses, among other topics, the foundation of astronomical physics, solar observations and theories, recent solar eclipses, spectroscopic work on the sun, the temperature of the sun, planets, and satellites, recent comets, stars, and nebulæ, and methods of research.

It has been the intention of the author to secure the materials needed from the original authorities whenever possible, and the large number of references given throughout the work will prove of great value and assistance to students.

Considerable attention has also been paid to the biography of the more eminent workers in this field, and the story of the life of many of these men strikingly enforces the lesson that great results may be reached even under the most discouraging circumstances by honest devotion to the work in hand, joined with tenacity of purpose.

FORESTS AND FRUIT-GROWERS. By ABBOT KINNEY, of Kinneyloa, San Gabriel, California. Pp. 5.

THIS is an address which was prepared and read at the California Fruit-Growers' Convention, by request of the State Board of Horticultural Commissioners. It presents the damage which has been produced in consequence of the destruction of the forests in different parts of the world. Accompanying his address, Mr. Kinney sends an article on "Floods and Fires," in which he gives the matter a local application, exhibiting the injury that has been wrought in the neighborhood of his own home by forest destruction, and shows that more of the same kind may be anticipated from continued progress in the wasting work.

CIRCULARS OF INFORMATION OF THE BUREAU OF EDUCATION, 1885. Nos. 3 and 4. Washington: Government Printing-Office. Pp. 55 and 56.

CIRCULAR No. 3 is a review of the Reports of the British Royal Commissioners on Technical Instruction, with notes, by the late Charles O. Thompson, of the Rose Polytechnic Institute, Terre Haute, Indiana. No. 4 is an account of the organization and statistics of education in Japan.

UNITED STATES GOVERNMENT PUBLICATIONS. Monthly Catalogue. Vol. I. No. 12. Washington, D. C.: J. H. Hickcox. Pp. (of the volume) 292. Price, $2 a year.

IT is believed that, in the volume of the Catalogue now completed, no Government publication of the year has escaped notice. The number of publications mentioned is approximately given at three thousand. A copious index is provided. The Catalogue will be continued, though the subscriptions to it have not yet been flattering.

THE LIFE AND GENIUS OF GOETHE. Edited by F. B. SANBORN. Boston: Ticknor & Co. Pp. 454.

THIS volume is composed of the lectures on Goethe, or rather, those of them which were available for publication, which were delivered at the Concord School of Philosophy in July, 1885. The list includes lectures on Goethe's youth, by Professor H. S. White; his self-culture, by John Albee; his Titanism, by Thomas Davidson; Goethe and Schiller, by Rev. C. A. Bartol; Goethe's "Märchen," by Rev. F. H. Hedge; his relation to English literature, by F. B. Sanborn; "Goethe as a Playwright," by W. O. Partridge; "Das Ewig-weibliche," by Mr. E. D. Cheney; "The Elective Affinities," by S. H. Emery, Jr.; "Child-Life as portrayed by Goethe," by Mr. C. K. Sherman; "History of the Faust Poem," by D. S. Snider; "Goethe's Women," by Mrs. Julia Ward Howe; and "Goethe's Faust," by W. T. Harris. To these are added, as an introduction, an account of the Goethe Society and the Goethe Archives, and bibliography of Goethe's works, of works on Goethe, and of papers on Goethe, and two portraits of the poet.

AN APACHE CAMPAIGN IN THE SIERRA MADRE. By JOHN G. BOURKE. New York: Charles Scribner's Sons. Pp. 112. Price, $1.

THIS is a spirited and very interesting account of the expedition, under General Crook, in pursuit of the hostile Chiricahua Apaches in the spring of 1883. Its purpose is simply to outline some of the difficulties attending the solution of the Indian question in the Southwest, and to make known the methods employed in conducting campaigns against savages in hostility. The author makes it understood that for the better accomplishment of this object he has submitted an unmutilated extract from his journal kept during the whole period involved. The record having been kept in a style free from literary affectations, presents picturesquely the life of the campaign. The illustrations, showing the customs and arts of the Apaches, add much to the value of the book.

JOHN CABOT'S LANDFALL IN 1497 AND THE SITE OF NORUMBEGA. By EBEN NORTON HORSFORD. Cambridge: John Wilson & Son. Pp. 39, with Maps.

JOHN CABOT, in 1497, came upon a spot somewhere in New England which he called, after the designation given by the Indians, Norumbega. The French afterward built a fort called Norumbega, on a river of the same name. The site has since been lost, but has usually been assigned to the banks of the Penobscot, although for reasons not judged sufficient. Mr. Horsford believes that he has found both Norumbegas—Cabot's on Salem Neck, and the French fort and town, on Charles River, between Riverside and Waltham, Massachusetts, where he discovered the remains of the fort. If the first determination is correct, Cabot is proved to have preceded Columbus in the discovery of (continental) America.

REPORT OF THE SMITHSONIAN INSTITUTION FOR 1884. Washington: Government Printing-Office. Pp. 903.

THIS volume contains the usual official reports of the proceedings of the Board of Regents, of the Executive Committee on financial affairs, and of the secretary, giving an account of the operations and condition of the Institution for the year 1884, with the statistics of collections, exchanges, etc. To these are added, in the Appendix, a record of recent progress in the principal departments of science, and special memoirs, original and selected, on various subjects. Among the memoirs are several papers of particular interest in anthropology, among which we may mention Mr. Vreeland's on the antiquities at Pantaleon, Guatemala—very curious sculptured figures, unique in American aboriginal art—and Professor Mason's account of the Guesde collection of antiquities in Pointe-à-Pitre, Guadeloupe.

PUBLICATIONS RECEIVED.

Darling, Charles W. Anthropophagy, historic and pre-historic. Utica, N. Y. Privately printed. Pp. 47.

Shufeldt, R. W. Science and the State. Pp. 10.

Carter, J. M. G. The Relation of Ætiology to Evolution. St. Louis. Pp. 8.

The Journal of Heredity. Edited by Mary Weeks Burnett, M. D. Quarterly. Chicago. Pp. 48. $1 a year.

Society for the Promotion of Agricultural Science. Proceedings of the Sixth Meeting, Ann Arbor, Mich. 1885. B. D. Halsted, Ames, Iowa, Secretary. Pp. 59.

Hilgard, Eugene W. Report on the Viticultural Work of the College of Agriculture, University of California. 1883–1885. Pp. 210.

Proceedings of the Colorado Scientific Society. 1885. Whitman Cross, Secretary. Pp. 36.

Mills, T. Wesley, Montreal. The Action of Certain Drugs and Poisons on the Heart of the Fish. Pp. 7.

Curtis, George T., and Richards, F. S. Arguments, in the Supreme Court of the United States, on Religious Liberty and the Rights of Conscience. Pp. 80.

Curry, S. S., Boston. School of Expression. Second Annual Catalogue. Pp. 12.

Von Taube, G. The Fitting School, Gramercy Park, New York. Pp. 86.

Ryder, John A. On the Development of Viviparous Osseous Fishes and of the Atlantic Salmon. Washington: Government Printing-Office. Pp. 85. With Seven Plates.

Cornell University. Proceedings in Memory of Louis Agassiz and in Honor of Hiram Sibley. 1885. Pp. 88.

Foster, Michael, and others. "The Journal of Physiology." Vol. VII, No. 1. Cambridge, England. Pp. 80. With Three Plates. $5 a volume.

Martin, H. N., and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. III, No. 7. Baltimore: N. Murray. Pp. 50. With Plates. 30 cents. $5 a volume.

Boston Society of Civil Engineers. Comparative Size of Metric and Old Units, and Report on Weights and Measures. Pp. 28.

United States Bureau of Statistics Quarterly Report of Imports, etc., to March 31, 1886. Washington: Government Printing-Office. Pp. 180.

Some Funny Things said by Children. New York: J. S. Ogilvie & Co. Pp. 62. 10 cents.

"Journal of the American Chemical Society." New York: Monthly. Pp. 24. $5 a year.

Wood, E. A., M. D., Philadelphia. Heredity and Education. Pp. 12.

Frazer, Persifor. The Application of Composite Photography to Handwriting. Pp. 10.

Purdue University, Lafayette, Ind. School of Pharmacy. Third Annual Announcement. Pp. 8; Bulletin No. 1. Pp. 22.

School of Pharmacy, University of Michigan. Annual Announcement for 1886-'87. Ann Arbor, Mich. Pp. 44.

Marcou. Annotated Catalogue of the Published Writings of Charles Abiathar White. Washington: Government Printing-Office. Pp. 64.

Curtiss, Romaine J., M. D., Joliet, Ill. State Control of Medical Education and Practice. Pp. 32.

Skidmore, Professor S. T., Philadelphia. The Burial of an Ass. Pp. 15.

Austen, Peter P., New Brunswick, N. J. The Purification of Water by Alum. Pp. 4. Dinitrosulphocyanbenzene. Pp. 3.

Historical Society of Southern California. Los Angeles. January, 1886. Pp. 43.

Hartwell, Edward Mussey. Physical Training in American Colleges and Universities. Washington: Government Printing-Office. Pp. 183. With Plates.

Wadsworth, M. E. On a Supposed Fossil from the Copper-bearing Rocks of Lake Superior. Pp. 4. List of Publications, 1877-1885. Pp. 3.

Kennedy, J. F., M. D. Typhoid Fever. Pp. 14. Health Laws of the State of Iowa. 1886. Pp. 43.

Smithsonian Accounts of Progress in 1885. Geography, by J. King Goodrich, pp. 36; Chemistry, by H. Carrington Bolton, pp. 50; Astronomy, by William C. Winlock, pp. 114; North American Invertebrate Paleontology, by John Belknap Marcou, pp. 46; Anthropology, by Professor Otis T. Mason, pp. 56; Mineralogy, by Professor E. S. Dana, pp. 26; Vulcanology and Seismology, by Professor Charles G. Rockwood, Jr., pp. 23; Physics, by Professor George F. Barker, pp. 60. Washington: Government Printing-Office.

Warden, Florence. Doris's Fortune. New York: D. Appleton & Co. Pp. 194. 25 cents.

Cassell's National Library. No. 20. The Battle of the Books and other Short Pieces. By Jonathan Swift. Pp. 192. Poems. By George Crabbe. Pp. 192. Egypt and Scythia described by Herodotus. Pp. 192. 10 cents each.

Tchernychewsky, N. G. What's to be Done? Translated by Benjamin R. Tucker. Boston: Benjamin R. Tucker. Pp. 329. $1.

The Cognitive Powers. By James McCosh. New York: Charles Scribner's Sons. Pp. 245. $1.50.

The Mystery of Pain. By James Hinton, M. D. Boston: Cupples, Upham, & Co. Pp. 121.

Kedzie, J. H. Solar Heat, Gravitation, and Sun-Spots. Chicago: S. C. Griggs & Co. Pp. 304. $1.50.

Chamberlin, Edwin M. The Sovereigns of Industry. Boston: Lee & Shepard. Pp. 186.

Harris, Amanda B. Old School-Days. Boston: Interstate Publishing Company. Pp. 109. 60 cents.

Kirke, Edmund. The Rear-Guard of the Revolution. New York: D. Appleton & Co. Pp. 317. $1.50.

Hoffman, K. B., and Ultzmann, R. Analysis of the Urine. New York: D. Appleton & Co. Pp. 310. With Eight Plates.

Steam-heating Problems. New York: The Sanitary Engineer. Pp. 233. $3.

Logan, John A. The Great Conspiracy. Its Origin and History. New York: A. R. Hart & Co. Pp. 810. With Plates.

Abbott, Helen C. de S. Preliminary Analysis of the Bark of Fouquieria splendens, pp. 8; Yucca angustifolia, pp. 32.

POPULAR MISCELLANY.

The Nineteenth Century Club. — The Nineteenth Century Club has completed its fourth season of lectures and discourses with undiminished interest on the part of its constituency. The organization has been true to its idea of securing the presentation of all sides of important questions. Besides its social success, its general intellectual and moral influence has been salutary. In the discussions just concluded the conservative side of thought has been represented by the Rev. Mr. Haweis, Rev. William Lloyd, Rev. Dr. Edward McGlynn, President McCosh, the Hon. C. M. Depew, F. R. Coudert, and President Porter as leading speakers. The views of President Eliot, of Harvard, were controverted by President Porter and Dr. McCosh. President Porter also had a discussion on "Evolution" with Professor E. S. Morse, of Salem, and Professor H. Newell Martin, of Johns Hopkins University, but his address took up so much of the evening that the other side had no opportunity to be heard with corresponding fullness.

New Light on "Arbitration and Conciliation."—Much has been written on the supposed labor question which the events of the last six months have made obsolete. Of this kind is a large part of "a plea for arbitration and conciliation," as embodied in a pamphlet on "Labor Differences and their Settlement," by Mr. Joseph D. Weeks, of Pittsburg, which has been sent us, bearing the imprint of the Society for Political Education. If workmen were always the gentle, much-enduring lambs that this author assumes them to be, there would be a place to make the peaceful ways of settlement between them and their employers which he suggests the rule. But where can arbitration and conciliation come in in such cases as the New York Steam-Heating Company and the Gray and the Landgraf boycotts, and the Texas Pacific and Third Avenue and Lake Shore Railroad strikes and their attendant "tie-ups"? These events have cast a new light on the matter; and those writers who are advising employers to submit the control of their concerns to outside organizations and are asserting the equal

right with employers to "determine" of men who are ready to destroy the establishment if it does not discharge its most faithful hands or overlook the transgressions of its unfaithful ones at their bid, will have to stand in the background till workmen have learned the duties they owe to one another and to society.

The "Profits" of Silk-Culture. — We published an article, last month, entitled "An Experiment in Silk-Culture," in which the writer made it very apparent that the business in this country, even when conducted with the most painstaking care, is likely to prove anything but a paying venture. Here is more testimony to the same effect, from a correspondent of the "Chicago Inter-Ocean": "Had I a pen of fire, and the sky for a scroll, and could I fly on the wings of the wind, I would at once start on my 'mission of mercy,' and, soaring through space from our blue Susquehanna to the mighty Pacific, I would inscribe in my flight in burning letters across our land, 'Let silk-culture most severely alone!' I know whereof I speak. I tried it to perfection under the most auspicious and exceptionally favorable circumstances—with every means and appliance at hand for 'clearing' two hundred dollars in the six weeks required to attend to the 'crop.' Within thirty miles of a market for the cocoons, with every surrounding the most encouraging, my hopes were high—but it was all a dead loss of time and money and work. It all ended in just forty-five cents worth of cocoons! I know how plausible it looks and reads. I know the inducements held out by silk-culture associations. I know, too, that the whole thing is as empty as a last year's bird-nest, and I, who have been so severely 'burned,' would fain caution others about going near the fire." The "Boston Herald" takes the same view, and is equally emphatic. It says: "The pleasant romance about the money made by girls throughout the country in raising silk comes to us every spring in an Associated Press dispatch, stating that the Agricultural Department is distributing silk-worm eggs to sanguine and enthusiastic applicants. When these worms are taught to look after their own sanitary arrangements, and, like the industrious ant, to garner food for their ravenous appetites, then the question of giving them the use rent free of some deserted shed or barn, in the hopes of getting a slight return for such worthless real estate, may be considered. Until the habits of these helpless and hungry paupers are improved, however, we advise all those who place the slightest value on their time and patience to shun the industry (an industry it is, with a vengeance!) as they would the advice of a quack advertisement. A few eggs will give one an entertaining and instructive lesson in natural history; an ounce of eggs will lead to trouble and vexation of spirit, an exasperating expenditure of time and patience, and absolutely no return, even for the rent of a wood-shed."

Parsee Children.—According to a writer in the "Westminster Review," when a child is born in a Parsee family, the exact time of its appearance is recorded, to a second. On the sixth night of its life, paper, pen, and ink, with some red powder and a cocoanut, are placed at the bedside of the child, so that "the goddess who presides over the infant" may record its destiny. In a few days an astrologer—it does not particularly matter of what religion he may be—is called in to cast the babe's nativity from the carefully recorded date of its birth. By the light of this sort of horoscope, he announces the names from which a choice may be made for the child, according to their affinity with the stars that were in the ascendant at the time of its birth. The Parsees having no fixed surnames, the son adds the name thus given him to the name which was similarly given to his father, dropping the grandfather's name which the father had assumed. If he be named Ardeshir and his father was named Framji, he becomes Ardeshir Framji. If his child, again, be named Pestanji, he is distinguished as Pestanji Ardeshir, and his son, in the following generation, might be Jehangir Pestanji. The Parsees possess in all about forty-nine names of Persian and twenty of Hindoo origin; hence there are always many persons bearing identical names. Further to distinguish between them, it has become customary to take as an *atak*, or distinguishing suffix, the name of a man's calling. So we may have Manakji Kavasji Su-

tar, or Manakji, the son of Kavasji, the carpenter. At the age of about seven years, the child receives the investiture of the holy shirt and girdle, accompanied with ceremonies calculated to impress him with the solemnity of the act, among which is his recital of the confession of faith in the Zoroastrian religion. The *sadarah*, or holy shirt, is a light, short muslin garment, worn next to the body; the *kosti*, or holy girdle, is a thin woolen cord of seventy-two threads, passed thrice round the waist and tied with four knots. The wearer, in tying the first knot, declares his belief in the doctrine of the one God, and at the second knot his faith in Zoroaster as the true prophet. In tying the last knot he says, "Perform good actions and abstain from evil ones." It is his duty, as soon as he has risen from sleep, to put on his *kosti*, wash his hands, and put wood on the fire. The astrologer has no place in the ceremony of investiture, but he presides over the arrangement of marriages, which take place early and usually between near relatives. The betrothal, the astrologer having pronounced the signs favorable, is made complete by the mere exchange between the parents of new dresses for the boy and girl.

Origin of Cancer.—Dr. H. Percy Dunn, of the West London Hospital, who has given attention to the study of cancer and the investigation of the causes of its increase in civilized countries, controverts the opinion that the disease is hereditary. The fact is admitted that cancer appears frequently consecutively in certain families, but this is not considered sufficient of itself to constitute an hereditary quality, while all the other characteristics of hereditary disease are absent. It fails to fulfill Quatrefages's definition of the hereditary quality, of becoming an agent of variation, and transmitting and accumulating the modifying actions of the conditions of life. But, while cancer is not transmissible as a disease, the predisposition to it may be inherited. The term predisposition is vague and hard to define, but may be described generally as "the shadow of a disease, as a disease without its substance—the reflection, as it were, in the offspring, distinct from the repetition of the morbid types common to one or both parents." The strongest element in the production of cancer is age, and it is most likely to appear between the thirty-fifth or fortieth and the sixtieth years. The disease may also be regarded as climatic or racial, prevailing most in the English climate and among the English people. It prevails most largely among women, and of them most with those who have had children. It is so prominently a nervous disease that Dr. Dunn gives his assent to the opinion that it may be and often is provoked by nervous shock. He, therefore, recognizes the expediency of preventing persons of middle age from being exposed to such shocks. In this relation to the nervous system, which is so trying in our busy age, is perhaps to be found the reason of the rapidly accelerated increase of cancer which has been lately remarked upon in England.

The King-Crab in New Waters.—Quite a sensation was stirred up among the fishermen of San Francisco on the 26th of May by the discovery of what was supposed to be a new crustacean. The creature was taken in the waters off the Farallone Islands by Captain Camillo, who was fishing there in his smack. When seen by some members of the United States Geological Survey, the "new crab" proved to be an old acquaintance, the *Limulus Polyphemus*, so common in the waters of the Eastern coast, where it is known as the king-crab on account of its great size, and the horse-foot crab because of its form. The living genus *Limulus*, if we reject two doubtful forms, has but three species—our own *L. Polyphemus*, the *L. moluccanus* of the Spice Islands, and *L. rotundicaudus* of the Chinese and the Japanese waters. Geologically considered, this strange creature has the highest antiquity of any of the crustaceans. And its place in nature is a problem of profound difficulty. Dr. Samuel Lockwood, so long ago as 1869, showed that in form the larval Limulus was identical with the trilobite. Since then embryological and anatomical study has shown that the animal is not a crab, and it is now even doubtful which it favors most, the position of an aquatic scorpion or an aquatic arachnidan; for it really seems to have structural elements of both the spider and the scorpion. It is also interesting to know that, while the trilobite

succumbed to geologic causes and became extinct, Limulus survived the most stupendous changes of land and sea. Whatever the species of the San Francisco specimen may be, as the first one taken in the Pacific waters it is highly interesting. But, supposing the specimen to be correctly determined as the species *Polyphemus*, that becomes a fact of very high significance. Although our Eastern king-crab survived the subsidence of large land areas, and the localizing of new seas, it was shut into a very circumscribed habitat — the eastern waters of the North Atlantic and the West Indies, and not even found in South America. In a word, it is an Atlantic form, and in its new habitat furnishes a fact as remarkable as if an African lion should be discovered in the American forests. It is almost a certainty that its appearance on the Pacific coast comes of an accidental introduction of some Limulus-eggs at the time that the United States Fish Commission introduced into the California waters a lot of lobsters taken from the East, as an experiment in stocking the Pacific coast. This was seven or eight years ago. The above fact is another illustration of the faunal and floral distribution brought about by man, often, as in this instance, by sheer accident. In the parlance of geologic time, it is a certainty that all plant and animal forms, however restricted their habitats in Nature may be, if they will bear acclimatizing, will soon become so cosmopolitan that their history as indigenes can only be obtained from libraries, where their life records shall be found as the published work of the naturalists of to-day.

Education and Crime.—The London "Spectator" remarks that the old idea that education would of itself extirpate crime has gradually been dissipated by experience. "It was a foolish idea *a priori*, for there is nothing in the mere development of intelligence to remove the original causes of crime or to cure either malice, or lust, or greed; and it died away before the evidence that education rather changes the form of some kinds of criminality than extinguishes criminality itself. The educated man swindles when the boor would steal, but the instinct of thievishness is the same in both, while greed is slightly increased by education." It does not even make all men intelligent, for "the new Anarchist faction, which rejects all the teaching, not only of history, but of the commonest facts of experience, and even the conclusions of arithmetic, is led by educated men, sometimes of high intellectual attainments." M. Elisée Reclus, author of most delightful and learned geographical books, is an anarchist; Prince Krapotkine, who counsels the destruction of society by force, is a man of unusual cultivation; Mr. Hyndman, who, while he disclaims anarchism, avows a desire to seize all capital, equalize all men, and compel all to labor, is a graduate of London University; and many of the cosmopolitan revolutionists are men familiar with many literatures. We have further been told, time and again, and are still told, by the advocates of popular education, that that would be in itself a strong guarantee for social order. Education has gone on diffusing its benefits among larger proportions of mankind; and now while New England, Scotland, and Prussia, formerly among the most educated states, were also the most orderly, there are in Germany five hundred thousand socialists"; and "all over the Western world, discontent with the order of society, especially upon points which can not be altered, appears to grow deeper and more violent." Thus, while education may still give us much in the end, "the old enthusiastic hopes from it were, as regards the time of their fruition, evidently illusory. It is no more a panacea than any other, and the good it does is as slow to develop itself as the good that rain does. We have all been just like the poor, and have expected pleasant results too soon, and from mere decrees, and from too little labor."

Traits of the Somanlis. — Mr. F. L. James has given an account of an exploration made early in 1884 into the Somauli country of East Africa, in which he penetrated to places where he was the first European visitor. The people seem in many ways to approach more nearly to the ancient Egyptians than any other African race with which the author is acquainted. Their swords are exactly like those used by the ancient Egyptians. Every Somauli carries two spears, a shield, and a short sword, and

the slightest difference of opinion with his neighbor prompts him to draw his sword or thrust with his spear. But, if he takes life, he, or his tribe for him, has to pay a heavy fine in camels. They can nearly always show several wounds, and are as proud of those which are behind as of those which are in front. They can also survive the gravest wounds, and recover quickly from injuries that would surely kill a European. They have quick tempers, which, when aroused, are absolutely beyond control, but, if they can once be got to listen to arguments, they are easily persuaded. They are great talkers, and every new plan is discussed for hours. The debaters sit in a circle, and divide themselves into parties, each appointing a spokesman; and he, holding a stick in his hand, will draw intricate geometrical designs in the sand while he holds forth on the subject in discussion. They are keenly sensitive to ridicule, so that, when trouble occurs among them, it is only necessary to raise a laugh against the leader of the disturbance, when he will cover his face and disappear from the scene. Mr. James had difficulty in getting his Somauli escort to submit to anything in the way of a leader. They rebelled when he undertook to put head-men over the guard-squads; and only the sense of a common danger when they got into strange parts, and a threat to expel troublesome persons from the camp, would keep them in order.

Earthquakes in China.—Dr. MacGowan, in connection with a record he has made of fifteen very perceptible earthquakes that were observed in China last year, remarked that three classes of seismic phenomena are distinguishable in that country, an insular, a littoral, and an inland class. Formosa and Hainan are both centers of seismic actions which often affect the mainland; and a considerable agitation of the sea has been observed in many cases of Formosan earthquakes. The Formosan earthquake of December 9th was the most violent one that foreigners so far have experienced; but the tall and slender pagoda-towers that adorn all Southeastern China, having stood for centuries unaffected by earth-waves, afford evidence that the shocks, though frequent, are harmless. Occasionally earthquakes of the littoral region are followed by the appearance on the ground of substances designated "white hairs" by the Chinese. When Dr. MacGowan first gave attention to them he thought they might be acicular crystals precipitated by gaseous action, but further research seems to indicate that they are not mineral but organic. Three foci for interior earthquakes may be indicated, two of which, Szechuen and Shansi, are very far from volcanoes, while shocks are often reported from them as continuous for considerable periods.

A New Hot-Water Cooking Apparatus.—Mr. Edward Atkinson has invented a new process and a new apparatus for cooking, which he gives to the public. The apparatus is operated by the heat derived from a common kerosene-lamp or from a gas-burner. The theory of it is based upon the non-conducting properties of certain materials with which the oven may be jacketed or incased. The inventor prefers pine-wood, which he forms into a box having walls from one and a half to three inches thick, according to the time during which heat is to be maintained within it. This is lined with metal, to make it water-tight. From one side or end of the box is projected a metallic tube, starting from near the bottom, bent so as to form a rectangle, and returning into the box near the top. This serves the same purpose as the pipes affixed to the water-back of a range. Inside the lined box is put as much water as is needed, and in this are inserted the cooking-vessel or vessels, of whatever material, which may or may not fill the box, provided about half an inch of water is left between them and the metallic lining of it. The whole is provided with a safety-valve or open way, to let off steam if the water should boil. The box and its contents, including articles to be cooked, having been arranged, the heat of a kerosene-lamp or gas-burner is applied to the projecting pipe, whence the heat is transmitted to the water inside of the box. A variation in the construction of the box is to have double-walled linings, with a space of about half an inch between the walls, through which the hot water may circulate. These metallic

walls are jacketed with asbestine or a mortar made of diatomaceous earth—"fossil meal,"—and then incased in wood; but the process of cooking goes on more slowly in this apparatus than in the one previously described. By throwing a woolen covering over the apparatus as soon as the cooking is done, the food may be kept hot for a considerable time. As no evaporation takes place within the apparatus, the cooked food comes out of about the same consistency as it went in. Allowance must be made for this fact in the preparation of the dishes. Though all of his apparatus has been crude and his efforts mostly tentative, Mr. Atkinson has had excellent success with most of the dishes he has cooked in it. They came out as well cooked as in other apparatus, except that they are never browned. He believes that his invention is susceptible of great improvement and development. He invites suggestions looking to those ends, but desires that all improvements belong to the public, and that the use of his apparatus be not encumbered by any patents. The date of his communication to us is April 9, 1886. The name of "The Aladdin" has been given to the invention.

Oriental Carpets.—The art of weaving—applied first to goods for clothing and to hangings and curtains for the tents of the pastoral people—has existed in the East from the earliest times. The designs now used, it is supposed by Mr. Vincent J. Robinson—an enthusiast on the subject of Oriental design—in a lecture on the subject before the British Society of Arts, are the same as were in use in the time of Abraham, and probably for centuries before. A representation of weaving, in a tomb at Beni Hassan, Egypt, which is as old at least as Abraham's time, shows two figures at work at a loom precisely like those now in use all over the East. Peculiar and distinguishing patterns marked the work of each tribe, and it is still often possible for the expert to determine by these patterns the district whence particular carpets have originated. Floor-coverings are pictorially indicated in the pavements of the palace at Nineveh, where the design of the carpet, marked by an inlaying of colored tesseræ, became a part of the permanent pavement. These designs are the same as those of some of the carpets still in use in Syria. Babylon was an important center of carpet-manufacturing; but, after the Roman conquest of Persia, all the goods of the region took the name of Persian, and it has lasted. The history of carpets in India can not be traced so far back, because of the obscurity of the sources and references; but there is reason to believe that, two or even three thousand years ago, the Indians had attained a higher state of refinement than they now possess. While sheep producing qualities of wool other than the finest abound in various parts of India, the very finest wool, called *put*, is only to be found in Turkistan, in the undergrowth which appears in the cold season. The fleece is shorn and the *put* is combed from the under part of it. This wool is used in the Cashmere shawls. Wool of similar quality is grown in Afghanistan and Khorassan, and about Shiraz and Kerman and Herat, at mountain-heights ranging from 4,500 to 7,600 feet. Besides these wools, camel's and goat's hair and the hair of the yak and the ibex are employed in carpet-manufacture. The finest of these is the *peshur*, or hair that grows close to the body of the goat, which is procured chiefly in the mountains of Afghanistan. Silk is occasionally used in Southern India, and gives an exceedingly lustrous effect to the pile. A carpet in the Vincent Robinson Collection, made entirely of silk, and probably of the sixteenth century, is wonderful as a mere piece of weaving, having four hundred stitches to the square inch. The old carpets were colored—red, with kermes or madder; yellow, with the pomegranate; and blue, with indigo. The manipulation of the manufacture consists in knotting with a double twist the wool forming the pile of the carpet firmly upon the foundation. The workman sits near the ground, with his legs in a hole in front of his work, which is wound upon a roller as it is done. A workman can make five or six inches by eighteen of the coarser kinds, less of the finer kinds, per day. Mr. Robinson is greatly impressed with the seemingly unconscious and special artistic gifts of the carpet-makers, and ascribes much of their success to their abhorrence of novelty. Indeed, he would like to make it an axiom that in fine design novelty

must be excluded. The real carpet-industry of the East is threatened with ruin from the competition of inferior English prison-work and the introduction of modern so-called improvements; and the modern Smyrna carpets have so degenerated "as even, in England, not to be accounted ornamental."

Life-History of American Snails. — Snails, according to Mr. Binney's monograph on "American Land-Shells," live in the forest, passing the greater part of their lives sheltered under the trunks of fallen trees, layers of decaying leaves, or stones, or in the soil. In the early days of spring they come out in companies, to sun themselves, and—possibly—to make love. Their eggs, which are laid when the weather has become favorable, are deposited in bunches of from thirty to fifty or more, slightly stuck together without any order, under the shelter of the leaves, or at the sides of logs and stones, generally at as great a depth beneath the surface as the animal can reach, and are then abandoned. This act is repeated two or three times during the season. The embryo can be seen within the egg in two or three days after it is laid, and emerges in the course of from twenty to thirty days, according to the weather. The young animal gnaws its way out of the egg, and makes its first meal out of the shell it has just left, and is then a snail of about a whorl and a half. But it grows very fast. It begins to prepare for hibernation at about the first frost, by ceasing to feed, becoming inactive, and fixing itself to the under surface of the substance by which it is sheltered, or burrowing a little way into the soil. The aperture of the shell looks upward, and the snail closes it by forming a glutinous shell-substance over it which is called the epiphragm. In this condition it reposes till spring. It also forms an epiphragm when it is in danger of being dried up in long droughts. Snails dislike to expose themselves to the sun, and are most lively on damp and dark days and at night. The American species are for the most part solitary, and in this respect differ greatly from their European congeners, which are social. Those, however, which have been introduced from Europe—and they are not few—retain their native habits. The appendages which perform the office of teeth for snails are peculiar in structure and various in form, and they do good execution on whatever eatables the animals may attack. The slugs are snails without external shells; are more nocturnal in their habits than the other snails; and are seldom visible in the daytime, though there may be thousands of them around. They do not hibernate, although they are partially torpid in cold weather. They have the faculty of suspending themselves in the air by means of a thread which they spin from a mucus secreted within their bodies. They have also the power of secreting at any point, or over the whole surface of their bodies, a more viscid and tenacious mucus, having the consistence of milk and nearly the same color—which constitutes a fairly valid armor of defense for them. It protects them against irritating substances, against corrosive gases, water, alcohol, and heat. They leave a trace of their usual secretion on every object over which they pass. This secretion appears to be necessary to their existence, for death follows the failure of the power to form it. All the species are exceedingly voracious, and feed upon plants and dead animal matter. Living creatures are too quick for them. They do much damage in the night and then retire to their hiding-places, leaving the gardener to wonder in the morning what destroying monster has been working among his plants.

Autobiography of an Ancient Cyclone.— Mr. John T. Campbell, of Rockville, Indiana, has described in the "American Naturalist" his tracing, by means of "tree-graves," of the course of a cyclone which passed more than three hundred years ago. The date of the storm was marked by noting the age of an oak which had grown on the top of one of the "tree-graves" or mounds. Its course was found by inquiring where other "tree-graves" had existed or had been observed in the past, and was traced in a belt about a thousand feet wide for fifteen miles. The "tree-graves," as Mr. Campbell calls them, are the marks that indicate where trees have been blown over, and consist of a depression formed by the pulling up of

the ground by the roots of the tree, and a mound on the side of the pit toward which the tree fell, formed of the earth which was thus pulled up. They are commonly called "Indian graves" by the people, and are supposed to be spots where Indian burials have taken place. Where they are numerous, as in the path of Mr. Campbell's cyclone, they are supposed to mark the place where a fierce battle has occurred. In the wild forest these marks are, though more than three hundred years old, as well preserved and as distinct in outline as many made by trees that have fallen recently. But if the land is cleared and cultivated they disappear in a very few years under the action of the plow and of exposure to frost and rains. The preservation of the little mounds in the woods, which under the continuance of the conditions might last for five thousand or even ten thousand years, is due to the thin coating of forest leaves that lies upon them. "The leaves act as shingles in shedding the rains, so that they are not washed or worn down by the falling rain or melting snow. The frost does not penetrate through a good coating of leaves, and therefore they are not expanded and spread out by freezing and thawing. I can see a great difference between the mounds in the wild forest and those on land that has been set to grass and pastured a few years. The tramping of stock, and the frequent expansions from freezing, which the grass does not prevent, flatten them perceptibly. The grass, however, does preserve them against rain-washings."

Fossil Fish in New Jersey Trias.—The triassic shales beneath the overflow of the trap-rocks of the Palisades of the west shore of the Hudson River have frequently been searched for fossils, but little besides dim tracings has yet been found in them. Mr. L. P. Gratacap says, however, in a communication to the "American Naturalist," that Mr. F. Braun, of Weehawken, New Jersey, has lately found a number of fish remains in these slates, of which he has extracted specimens of considerable beauty, together with vegetable fossils. Among the remains are casts and impressions of plant-roots or root-like fragments, the lobate divisions of an aquatic plant, an enigmatical nut displaying its coaly and black nucleus, and numerous fishes in various stages of preservation, and in positions that seem to throw a light upon the local circumstances of their entombment. The fishes are apparently identical with *Palæoniscus latus*. In the sandstones below these shales, Mr. Braun has found tracks, ripple-marks, and rain-fossæ.

NOTES.

Emma H. Adams, in an account of "Salmon-Canning in Oregon" which is published in the Bulletin of the United States Fish Commission, says: "In the four large houses I visited, Chinamen were doing all the work of canning, under an American superintendent; and I believe every firm employs them. The process, consisting of not less than a dozen or fifteen different steps, requires at some stages great skill and celerity. For such work the lithe Celestial is well adapted. He is attentive, exact, prompt, faithful, and silent. Garrulous as a parrot with his countrymen usually, he is speechless if set to precise tasks, especially where his wages are to be proportioned to the amount of labor he performs."

The war against the phylloxera in France has been waged with wonderful vigor, and has resulted so far in redeeming more than half of the infected country from the attacks of the pest. The methods of fighting employed are first, submersion of the whole land until the invaders are drowned—the most effective method, but applicable only to low lands; second, carbon bisulphide, which kills by direct contact and by its vapor; and third, potassium sulpho-carbonate. In 1885 submersion was applied to 24,339 hectares; carbon bisulphide to 40,585 hectares; and the sulpho-carbonate to 5,227 hectares. Professor W. Mattieu Williams remarks on the way the French farmers have barred this visitation and succeeded in staying it, that it affords a clinching proof of the success of the system of peasant proprietorship, which has converted every rustic, even the very poorest, into a capitalist with a sufficient reserve to battle against such a calamity.

Fixed color-standards are in demand for anthropological purposes. Those which were issued by Broca several years ago show a tendency to fade. Mr. Galton, looking about him for something more durable, has decided upon the imperishable enamel which is employed for Roman mosaic-work, and has recently visited the Vatican manufactory for the purpose of obtaining typical colors among its products.

Dr. W. F. Morgan, of Leavenworth, Kansas, communicates to the "Medical Record" a story which would indicate that swallows have considerable surgical skill as well as intelligence. In a nest he found a young swallow much weaker than its mate, which had one of its legs bandaged with horse-hairs. Taking the hairs away, he found that the bird's leg was broken. The next time he visited the nest, he found the leg again bandaged. He continued to observe "the case," and in two weeks found that the bird was cautiously removing the hairs, a few each day. The cure was entirely successful.

Professor Robert von Helmholtz has published in Widermann's "Annalen" the final results of the experiments and arguments on the formation of mist. The air must contain a normal quantity of solid particles of dust, and must be free from bodies that will act chemically on aqueous vapor.

The Himmelbjerg, or Heaven Mountain, has until recently enjoyed the distinction of being the highest mountain in Denmark. It is four hundred and eighty-two feet high. It has now to yield the palm to two peaks recently measured in the forest of Ky, the highest of which is five hundred and thirty-two feet above the sea. These mountains have not been named; and it would indeed be hard to find a suitable name for a mountain overtopping the "Heaven-peak."

The fact has recently been confirmed by a number of observers that the electric eel can exert its power through the water to a distance. Professor W. Mattieu Williams relates that he once plunged both hands into water containing one of these fish, intending to grasp it, but failed to reach it; but he received a very severe shock when at some distance, probably three or four inches, "the sensational nature of the experiment rendering any approach to accurate estimation of the distance quite impossible."

The bascule is a new instrument for recreation, which has been developed out of the primitive see-saw by Mr. Piercy, of Birmingham, England. His first specimen was constructed for his own family. The bascule consists of a wooden beam, which is supported on a four-legged iron stand. The seats are so arranged as to remain always horizontal, whatever the position of the beam may be, while the adjustment for players of unequal weight is effected by a balancing block, which is slid along the beam till it reaches the point where it is wanted, and is there locked in position by the act of loosing the handle. The bascule has also a horizontal movement, and can be used as a merry-go-round.

A story of two sagacious crows is told in "Land and Water" by the Rev. F. O. Morris, on the authority of a land-owner of Loch Orr, who saw the birds annoying two hares. Although he could not see clearly, on account of the high grass, he was sure the hares had young ones, which the crows were trying to carry off. After the hares had fought the birds for some time, one of the "black robbers" managed to attract their attention, and led them off a little, while his confederate flew round and seized a small animal, which screamed loudly, when both birds flew away. He was satisfied that their purpose had been to get one of the young ones of the hares, and that they had succeeded.

Sir William Thomson has described a new form of spring-balance for the measurement of terrestrial gravity. One end of the spring is fastened, while the other end is weighted sufficiently to keep the spring straight when horizontally fixed. The spring is adjusted within a brass tube on a slope of about one inch in five, in which position it is in nearly unstable equilibrium. The observation consists in marking the number of turns of the micrometer series attached to the spring which are required to bring the weight from the balanced to the horizontal position. The instrument is sensitive to a forty-thousandth of the force of gravity, and to differences of temperature of $\frac{1}{10}$° C.

It is proposed to erect a monument to the memory of Thomas Edward, the Scotch naturalist whose death we have recently noticed. A committee has been formed, under the auspices of the town authorities and the scientific and literary clubs of Banff for the furtherance of this object, and invites subscriptions.

M. Chevreul, who attended the meeting of the French Academy of Sciences on the 17th of May, was there presented, in anticipation of his attaining a hundred years of age in August, with a bronze bust of himself, executed by M. Paul Dubois. The presentation was made at that time instead of waiting till the coming of M. Chevreul's birthday, on account of the approach of the summer vacation, which would take many of the members of the Academy away from Paris.

Herr Familiant, of Berne, has been studying the brain of a lioness, and finds that in form it is nearly intermediate between that of the dog and that of the cat. It is distinguished from both by relatively small projection of the cerebellum and narrowness of the *lobus pyriformis*. Further, the chief fissures of the brain of carnivoras are also to be found, with minor differences, in that of primates.

PROFESSOR A. VOGEL has observed that plants do not always contain their characteristic alkaloids when grown under other than natural conditions. Hemlock does not yield conine in Scotland, and cinchona-plants are nearly free from quinine when grown in hothouses. Tannin is found in the greatest quantity in trees which have had a full supply of direct sunlight.

THE severe weather of the early days of March in parts of England was very fatal to birds of the thrush tribe, many of which died from starvation and weakness. A total change of scene followed the turn of weather to warm, and the bird-life became one of general vigor and activity, with mating and singing, and nest-building constantly going on.

DR. C. BLAREZ says that the materials used for coloring wine, such as sulpho-fuchsine, are capable of setting up a great deal of gastric disturbance in persons having weak digestion.

WERKHOJANCK, in Siberia, latitude 67½° north, still maintains its position as the coldest place on the earth. A Russian Government surveying expedition reporting to the Academy of Sciences of St. Petersburg, concerning its temperature observations there in 1885, gives the mean temperature of the year as 17° C., or 1° Fahr., the mean temperature of January of that year as —49° C., or — 56° Fahr., and the minimum for the same month as — 68° C., or — 90° Fahr.

OBITUARY NOTES.

M. JULES CÉLESTIN JAMIN, one of the most eminent French physicists, died in Paris on the 12th of February. He was born in 1818, and spent most of his active life in scientific professorships. He was intrusted by Minister Duruy with the duty of opening the public lectures of the Sorbonne. He was made a member of the Physical Section of the Academy of Sciences in 1868, and was elected perpetual secretary, succeeding Dumas, in 1884. His most important scientific labors were in the field of optics. He also made investigations in capillarity, devised a new method of preparing magnets, introduced modifications into the Jablochkoff system of electric lighting, and at a later period devoted his attention to the hygrometer.

PROFESSOR HEINRICH FISCHER, of the University of Freiburg in Baden, who died last February, was a diligent student of microscopic mineralogy, and distinguished himself by his investigations on the origin and character of jade, concerning which he published, in 1875, the book "Nephrite and Jade."

MRS. ERMINNIE A. SMITH, who was a student of American anthropology of growing fame, died at her home in Jersey City, New Jersey, June 9th. She was born at Marcellus, New York, in 1838, and was taught in Mrs. Willard's Seminary at Troy. As President of the Jersey City Æsthetic Society, which she formed in 1876, it was her privilege to entertain many literary persons. In 1880 she was engaged by the Smithsonian Institution to investigate the folk-lore of the Iroquois Indians, and went among them, becoming a member of the tribe. At the time of her death she was employed in preparing a dictionary of the Iroquois language. She was a member of Sorosis, the New York Historical Society, the New York Academy of Sciences, and the London Scientific Society.

DR. JULIUS ADOLPH STÖCKHARDT, the eminent chemist, died at Tharandt, in Saxony, June 1st, in his seventy-seventh year. He was best known by the services he rendered to agricultural chemistry. He was the originator of the system of agricultural experiment stations now become so general, and was for many years director of the establishment of that character at Tharandt. He was successively editor of the "Polytechnisches Centralblatt," the "Zeitschrift für deutsche Landwirthe," and "Der chemische Ackersmann," and aided in the establishment of the journal "Die Landwirthschaften - Versuchs - Stationen." His writings were usually intended to make chemistry intelligible to lay minds; and one of them, translated and published as "Stöckhardt's Principles of Chemistry," has found much favor in this country as a text-book. A sketch by Professor Atwater and portrait of Professor Stöckhardt were given in the "Monthly" for June, 1881.

DR. E. LINNEMANN, Professor of Chemistry at Prague, died April 27th. He had prepared a communication, which was found among his papers, announcing the discovery, in the orthite of Arendal, of a new metallic element, which he called Austrium. M. Lecocq de Boisbaudran has, however, suggested that this metal is probably gallium, of which orthite contains a small quantity.

A. VON LASAULX, Professor of Mineralogy in the University of Bonn, who died in January last, was one of the most active of German workers in mineralogy and petrology. He was forty-six years old.

DR. CHARLES UPHAM SHEPARD, formerly of Amherst College and the South Carolina Medical College, died in Charleston, S. C., May 1st. He was the owner of extensive collections in mineralogy, which he gave to Amherst College a few years ago.

FREDERICK WARD PUTNAM.